Collaborating
On
Life Cycle Modeling
(Depot Level Maintenance)

Bridging The Gap Between

The Present

And

The Future

Landscape

RFI

Acquire
Purchase
Provision & Field

DRMO

Ship

BER

Depot
Repair

Trouble-
shoot

Test

Induct
at
Depot

Package/Preserve

Ship

Ship

Wholesale
Supply

Wholesale
Supply

Manage This!

Ship

War
Reserve

Ship

Package/Preserve

Trouble-
shoot

Retail
Supply

Field
Repair, I-level

Remove

Test

Field
Repair
O-level

Trouble-
shoot

Retail
Supply

Use/Break

Non-RFI

Decision Maker's Paradigm

- Decision makers at the tactical, program and enterprise level of acquisition and logistics answer three fundamental questions everyday…
  - How do I know when I have a problem?
    - Appropriate/Adequate Metrics
  - What's causing the problem?
    - Root Cause Analysis
  - What options or COA's exist that will solve my problem?
    - Estimating / Forecasting impact of feasible solutions…choosing optimal course of action

Different Perspective Same Data

Strategic

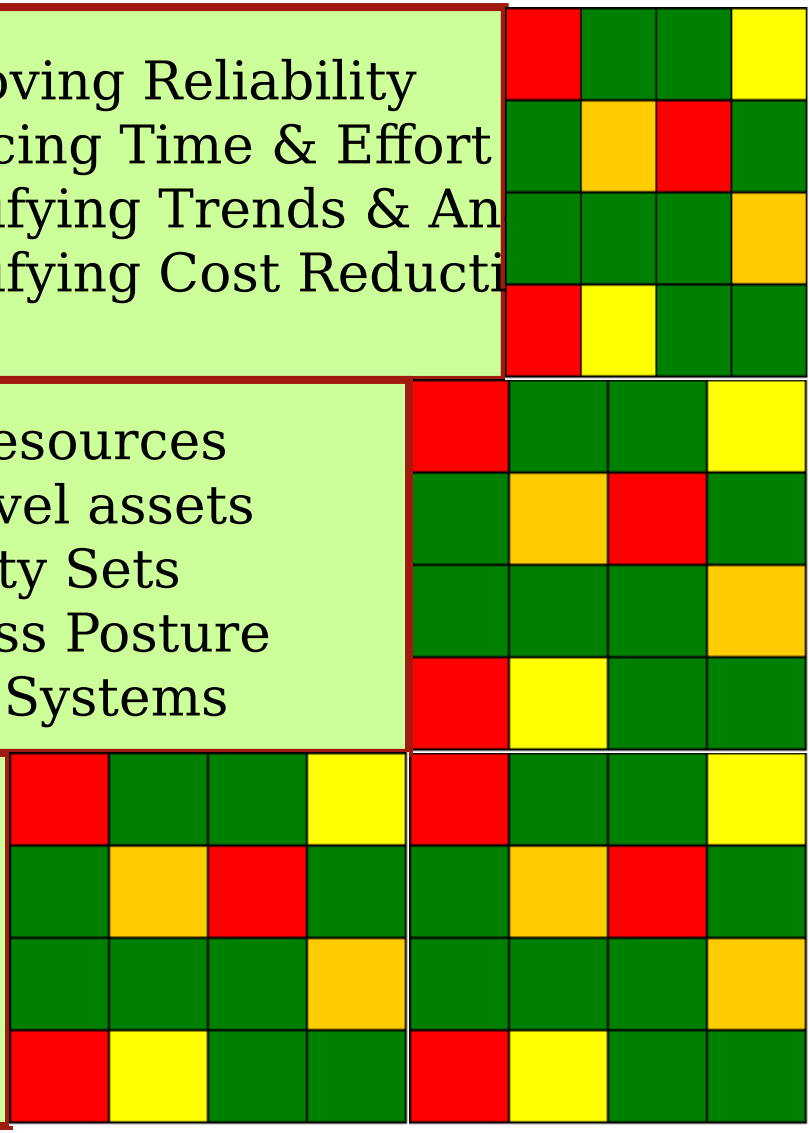
- Improving Reliability
- Reducing Time & Effort
- Identifying Trends & An
- Identifying Cost Reducti

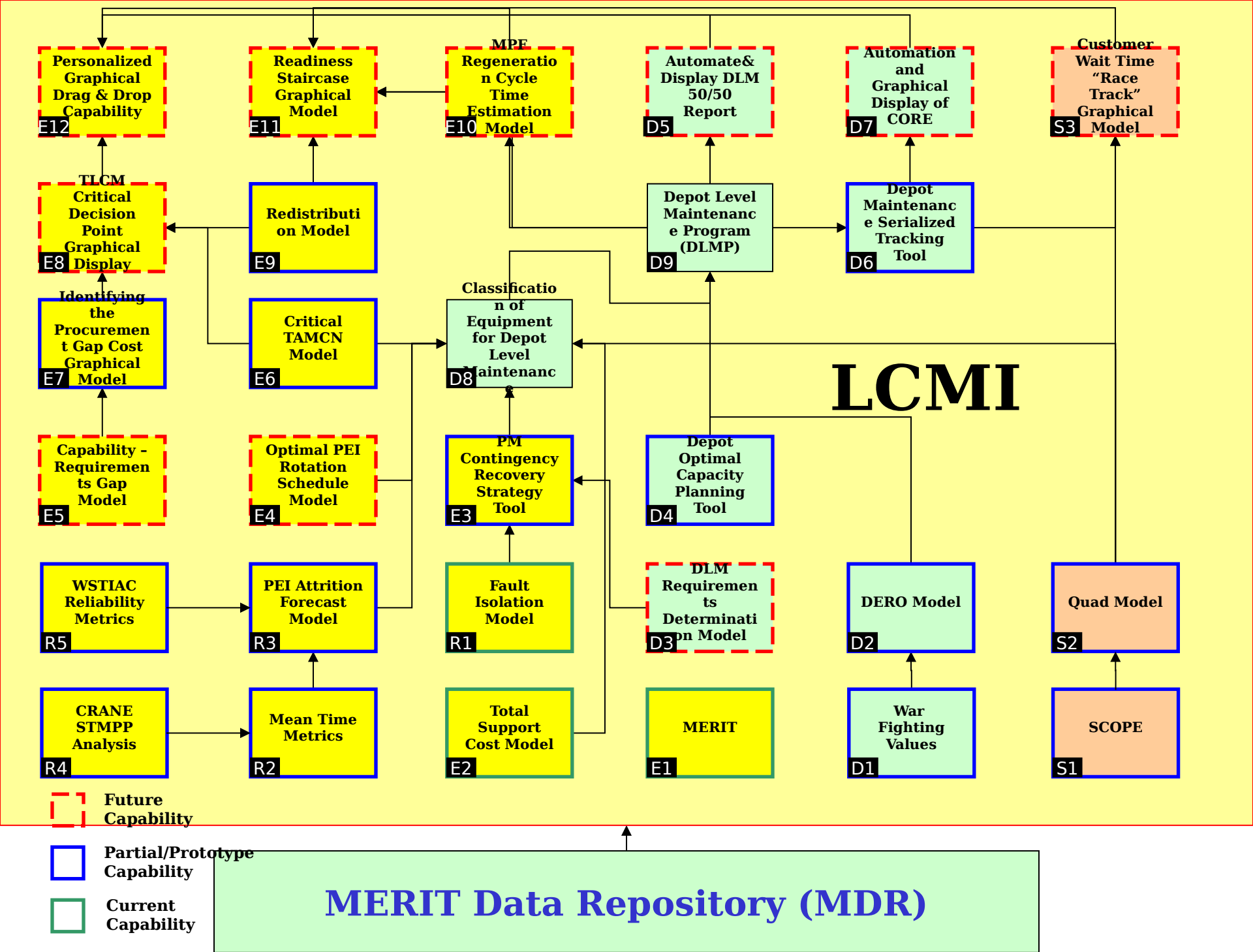
Operational

- Use of resources
- Cross-level assets
- Capability Sets
- Readiness Posture
- Weapon Systems Analysis

Tactical

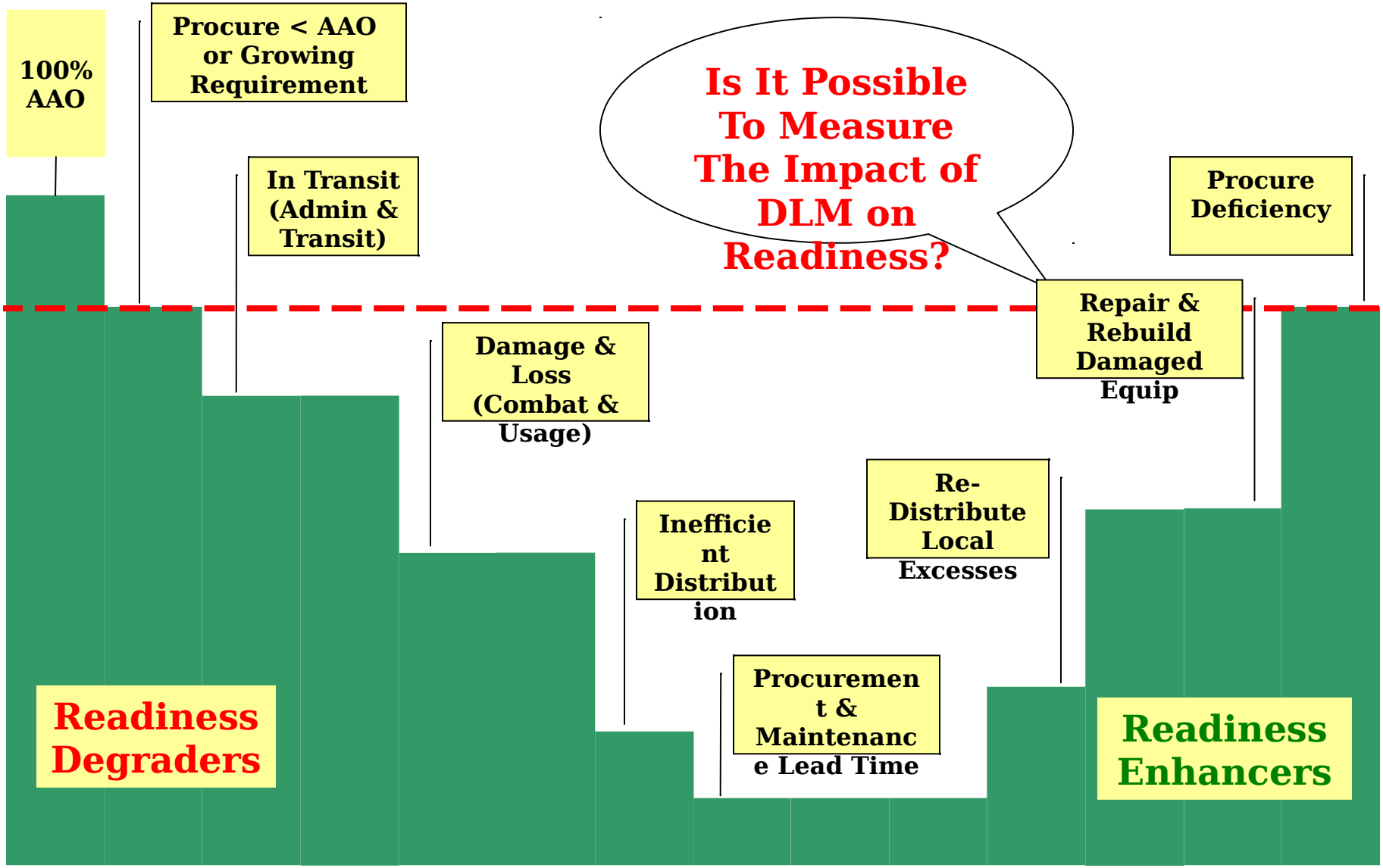
- Track requisitions
- Locate Equipment
- Monitor




Personalized Graphical Drag & Drop Capability
E12
Readiness Staircase Graphical Model
E11
MPE Regeneration Cycle Time Estimation Model
E10
Automate& Display DLM 50/50 Report
D5
Automation and Graphical Display of CORE
D7
Customer Wait Time "Race Track" Graphical Model
S3
TLCM Critical Decision Point Graphical Display
E8
Redistribution Model
E9
Depot Level Maintenance Program (DLMP)
D9
Depot Maintenance Serialized Tracking Tool
D6
Identifying the Procurement Gap Cost Graphical Model
E7
Critical TAMCN Model
E6
Classification of Equipment for Depot Level Maintenance
D8
LCMI
Capability – Requirements Gap Model
E5
Optimal PEI Rotation Schedule Model
E4
PM Contingency Recovery Strategy Tool
E3
Depot Optimal Capacity Planning Tool
D4
WSTIAC Reliability Metrics
R5
PEI Attrition Forecast Model
R3
Fault Isolation Model
R1
DLM Requirements Determination Model
D3
DERO Model
D2
Quad Model
S2
CRANE STMPP Analysis
R4
Mean Time Metrics
R2
Total Support Cost Model
E2
MERIT
E1
War Fighting Values
D1
SCOPE
S1
Future Capability
Partial/Prototype Capability
Current Capability
MERIT Data Repository (MDR)

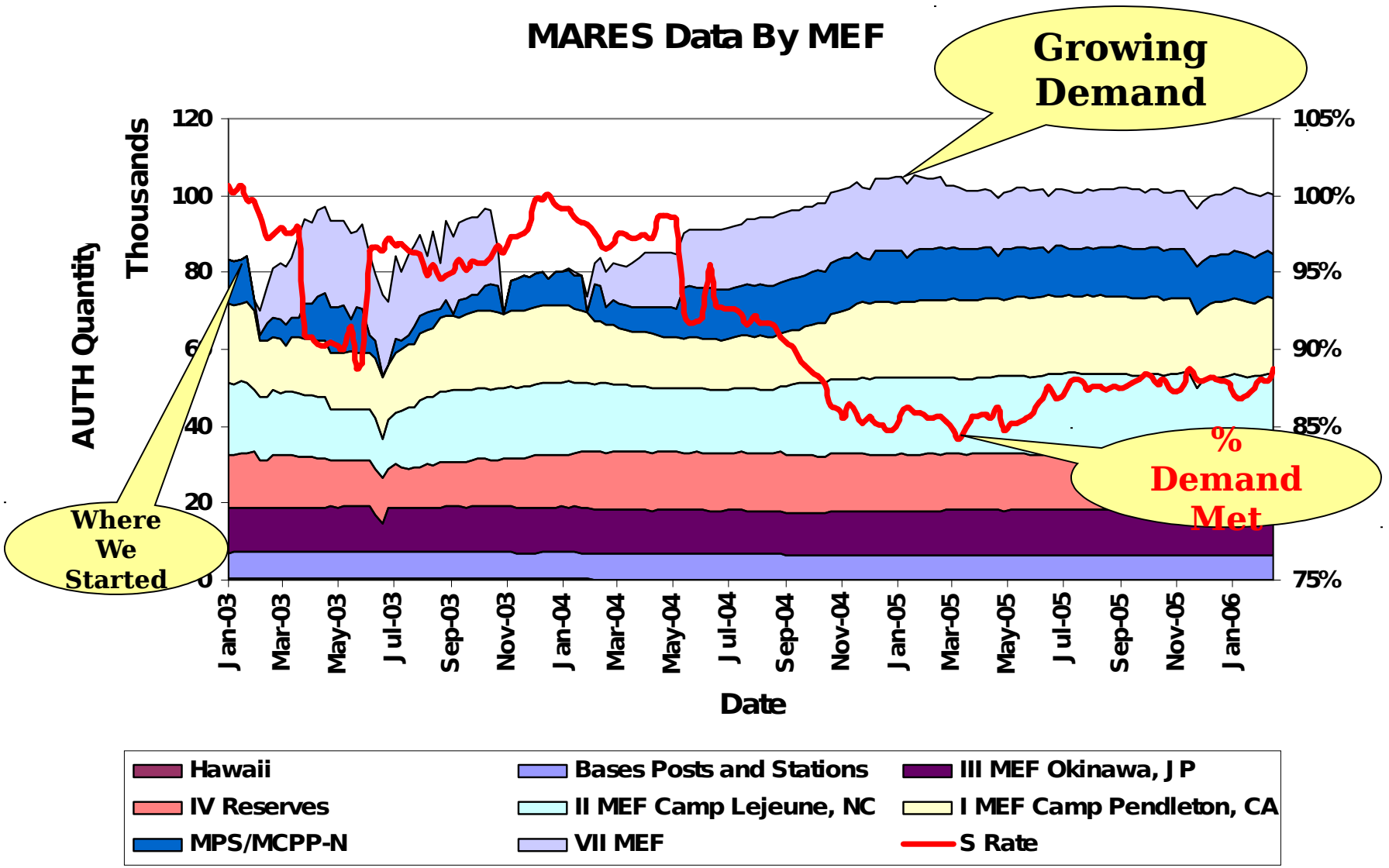
Readiness Metrics

What Impacts Materiel Availability?


100% AAO
Procure < AAO or Growing Requirement
In Transit (Admin & Transit)
Damage & Loss (Combat & Usage)
Inefficient Distribution
Procurement & Maintenance Lead Time
Re-Distribute Local Excesses
Repair & Rebuild Damaged Equip
Procure Deficiency
Is It Possible To Measure The Impact of DLM on Readiness?
Readiness Degraders
Readiness Enhancers

Historical

Materiel Availability ~ S Readiness Rate



Questions That Need Answers

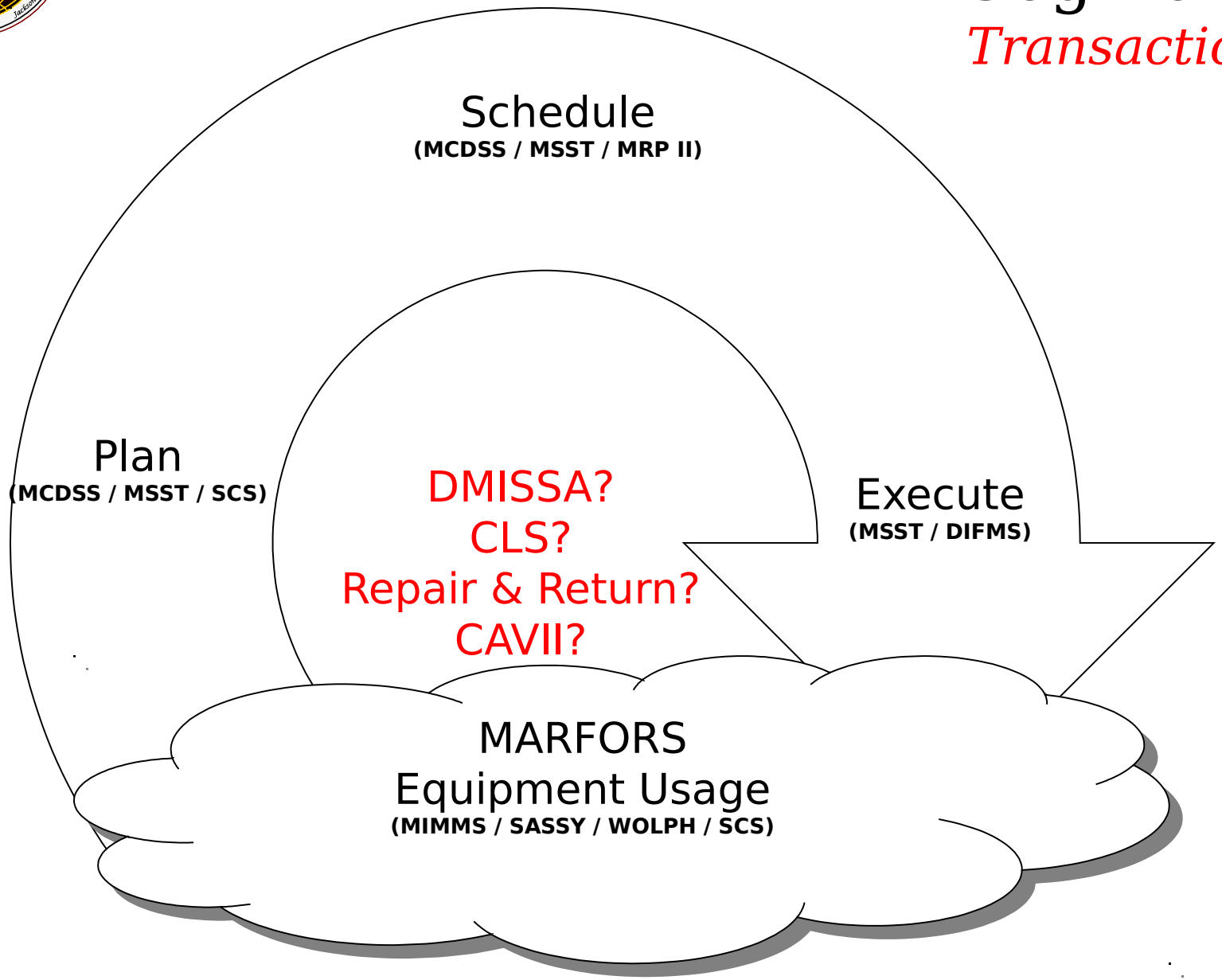
- How to portray three inter-dependent levels of interest?
  - HQMC
  - SYSCOM/LOGCOM
  - MARFORs
- How are the three segments of DLMP linked?
  - Planning (HQMC, SYSCOM, MARFORs, SCMC, P&R)
  - Scheduling (Maint Directorate, P&R, SCMC)
  - Execution (Maintenance Centers: MCA, MCB, CLS, DMISSA)
- What metrics, graphics, or displays will provide decision support capability at each level of interest?

Questions That Need Answers

- How can DMISA and CLS DLM visibility be attained?
- To which systems can we automate access and obtain reliable, accurate cost & budget data?
- What is the boss file for the Plan? The Schedule? Production?
- What root cause analysis models would be useful?
- What decision support tools are appropriate?
- …?

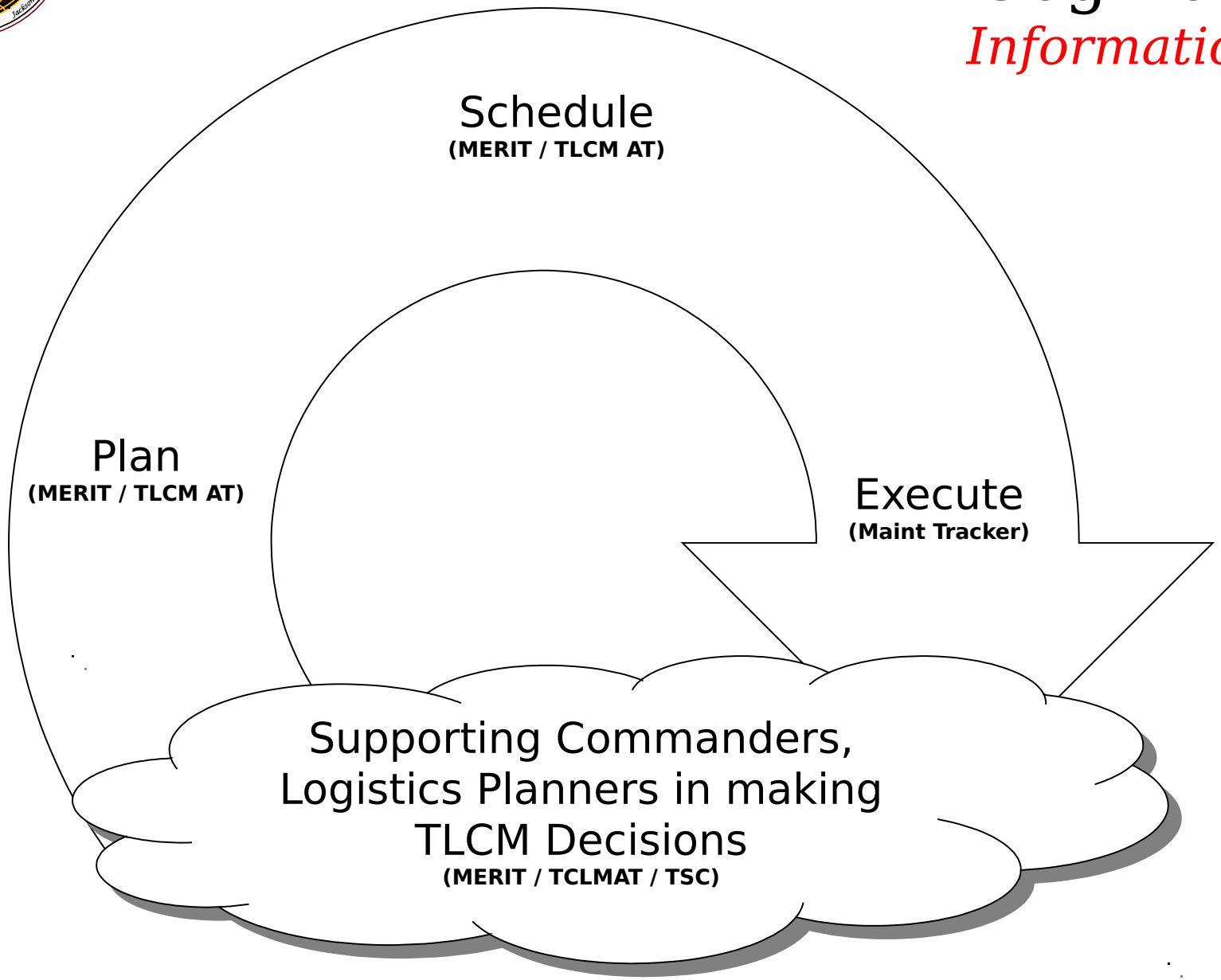
DM Segments

Transactional



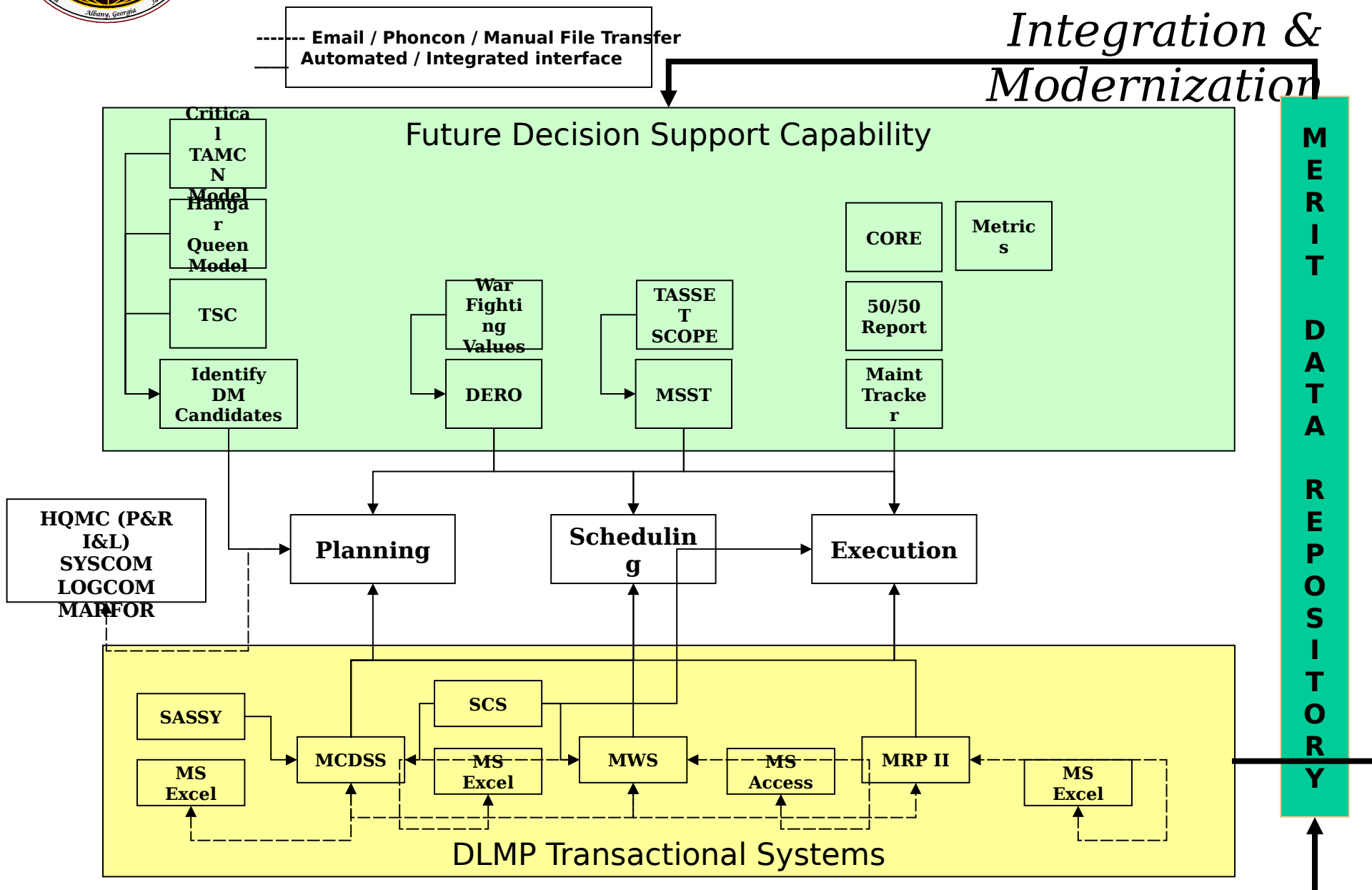
DM Segments

Informational



DLM Systems Relations

Integration & Modernization



How Do I Know If The DLM Process Is Working?

- What are appropriate metrics for measuring sustainment from a readiness perspective using existing data systems?
  - Materiel Availability
  - Reliability
  - Cycle Time (Logistics Response Time/Customer Wait Time)
  - Reduction of Total Costs
  - Others?
- Do these metrics show the contribution of Depot Level Maintenance to readiness?

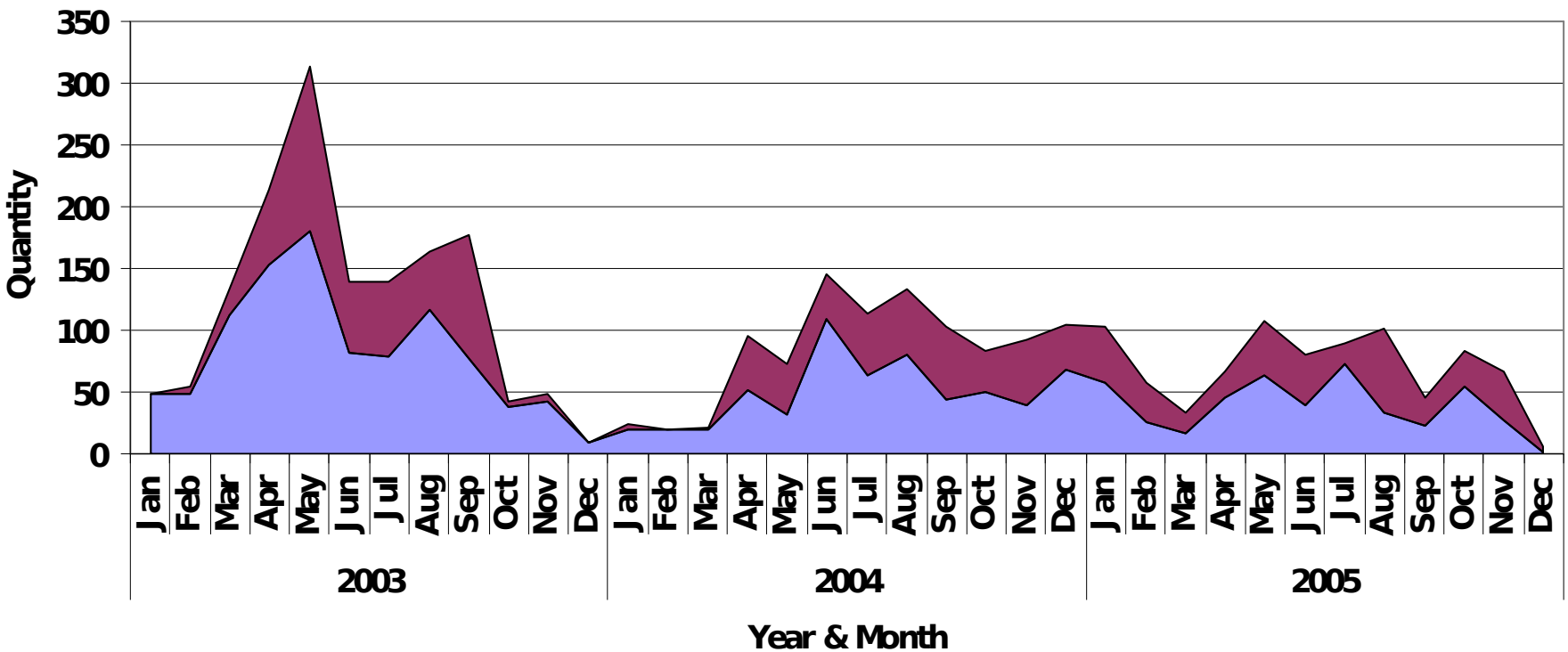
What Are The Expected Impacts Of DLM On Materiel Readiness?

- Materiel Availability (Ao)
  - Increase In Readiness
- Increased Reliability (RAM)
  - Reduced Level of Maintenance Effort (LOE) in Fleet
  - Increased Equipment Life Time

Historical

Aggregated Losses

Readiness Reportable
Repairable or Destroyed
2003 - 2005

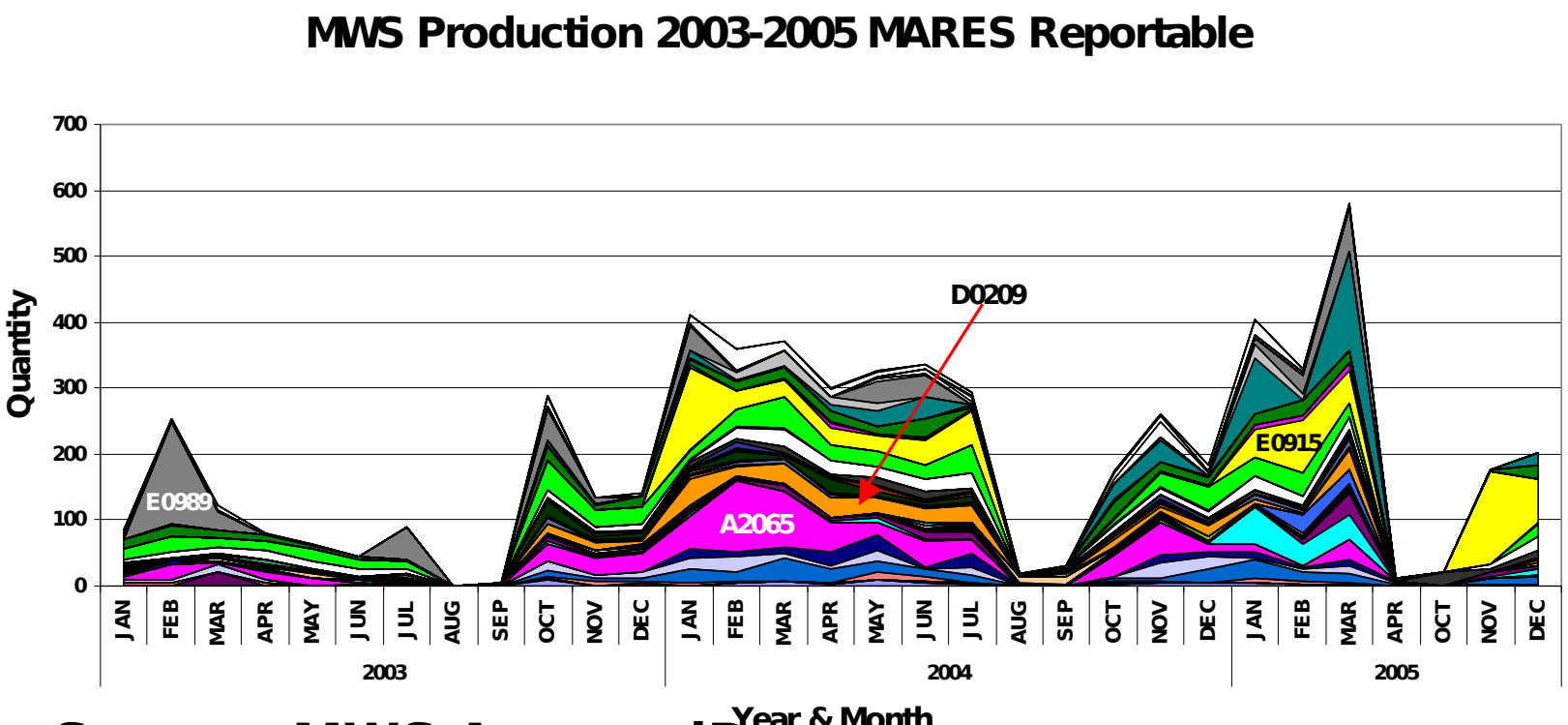


Data Source: WOLPH

Repairable
Destroyed

Historical

Depot Level Maintenance (DLM) Production

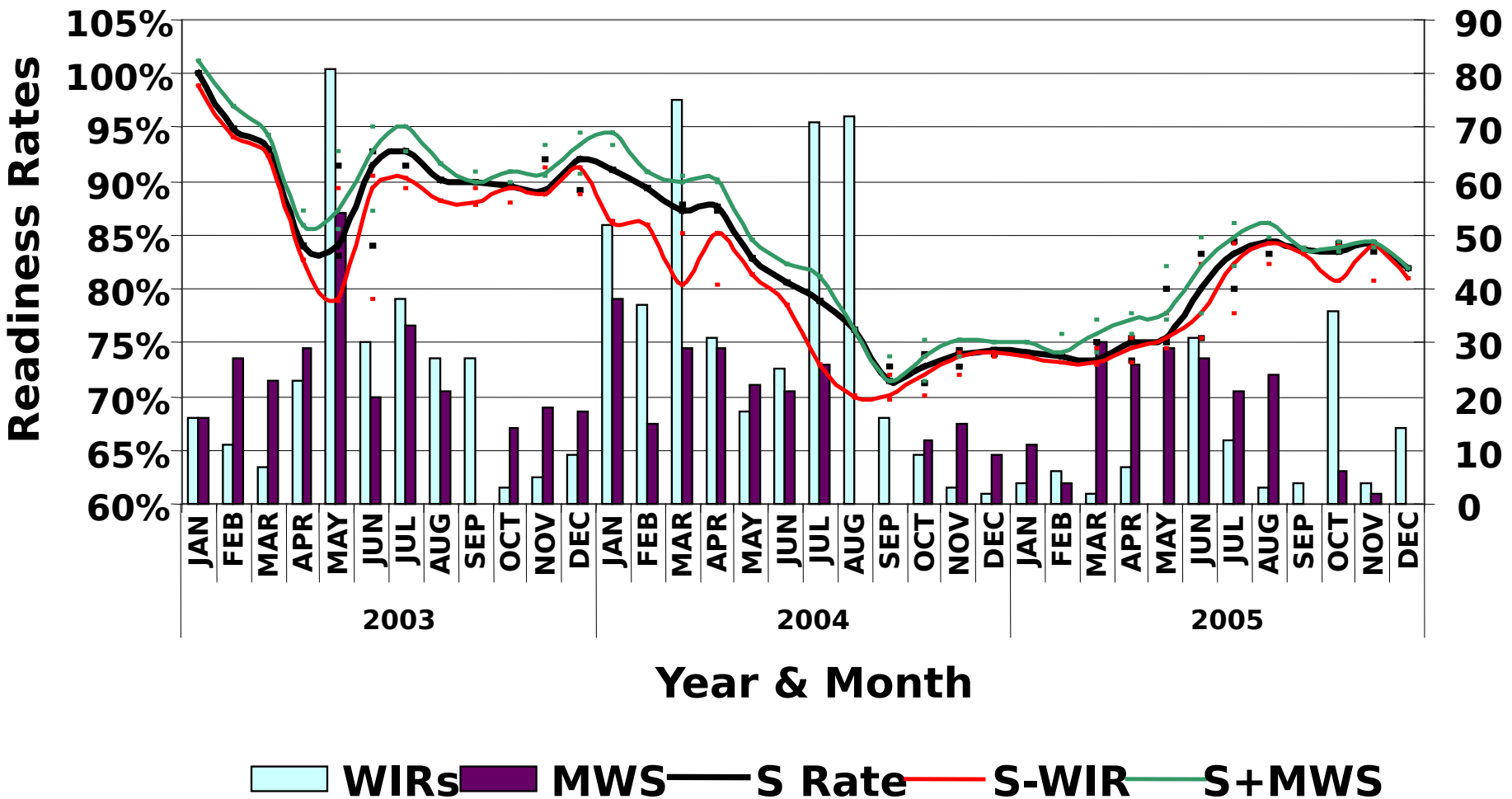


Data Source: MWS Access dB
LOGCOM (Maint Dir)

A0248 A0465 A0966 A1221 A1440 A1500 A1503 A1795 A1955 A2065 A2306 A2505 A2508 A2525 A3255 B0443 B0446 B0589
B1021 B1045 B1291 B1298 B1315 B1580 B2085 B2127 B2460 B2462 D0209 D0215 D0876 D0877 D0878 D0879 D0880 D0881
D1134 E0150 E0180 E0207 E0277 E0665 E0796 E0846 E0856 E0915 E0935 E0942 E0946 E0947 E0948 E0949 E0950 E0980
E0984 E0989 E0998 E1045 E1065 E1095 E1145 E1377 E1836 E1888 E1912

Observing the Impact Of Losses & DLM on Materiel Availability~S Readiness Rate

D0209 Summary



Can DLM Impact Reliability?

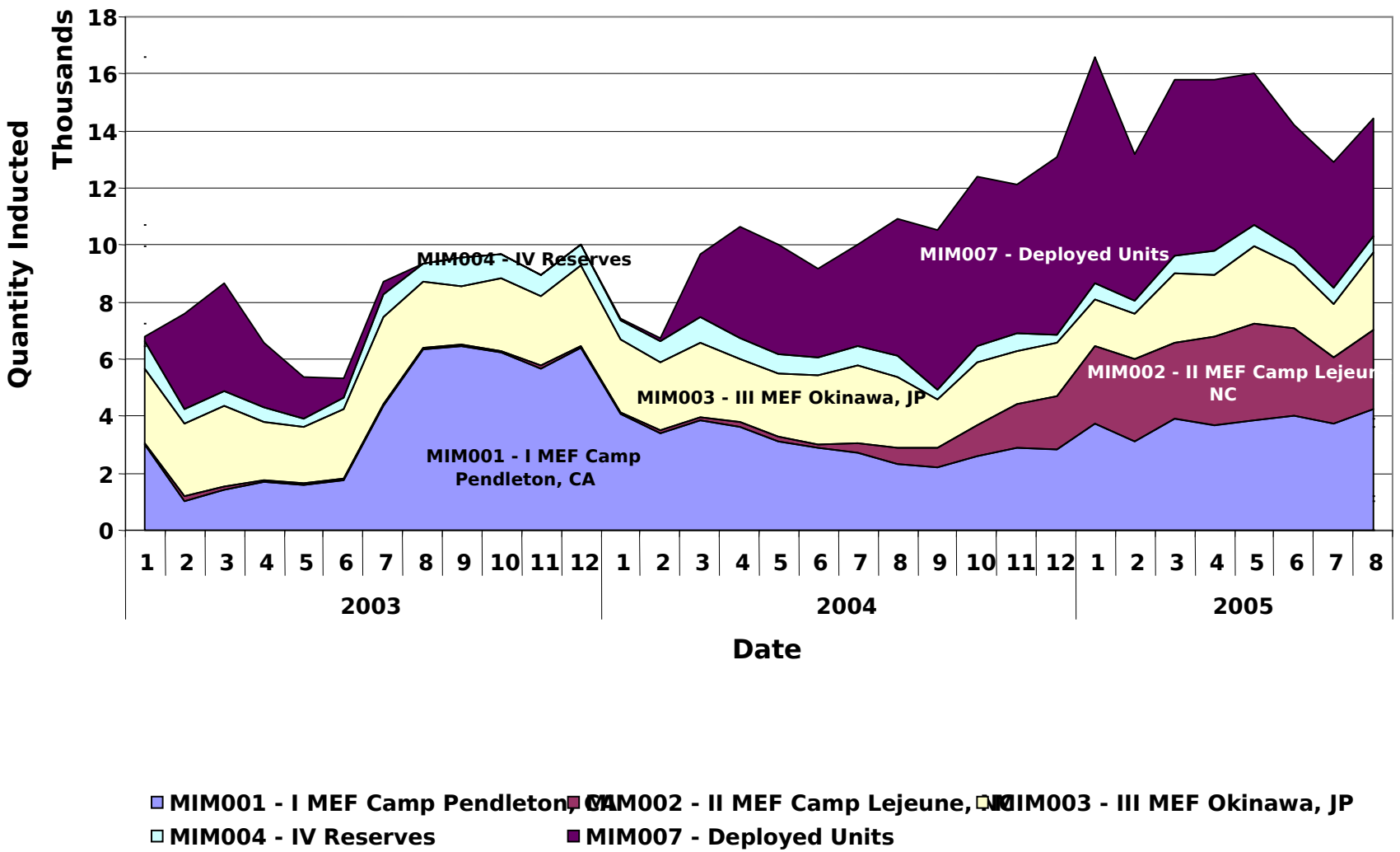
- What are indicators of reliability
  - The distribution of failures over time
  - How often, on average, a piece of equipment fails over time

$$R_T = \int_t^{\infty} \frac{1}{\mu} e^{\frac{-t}{\mu}} dt, \text{ where } \mu = \text{MTBF}$$

- Can we quantify the maintenance effort?
  - Maintenance actions performed over time
    - Preventive
    - Corrective

Decreasing Reliability Or Increasing Optempo?

Fleet Maintenance Effort

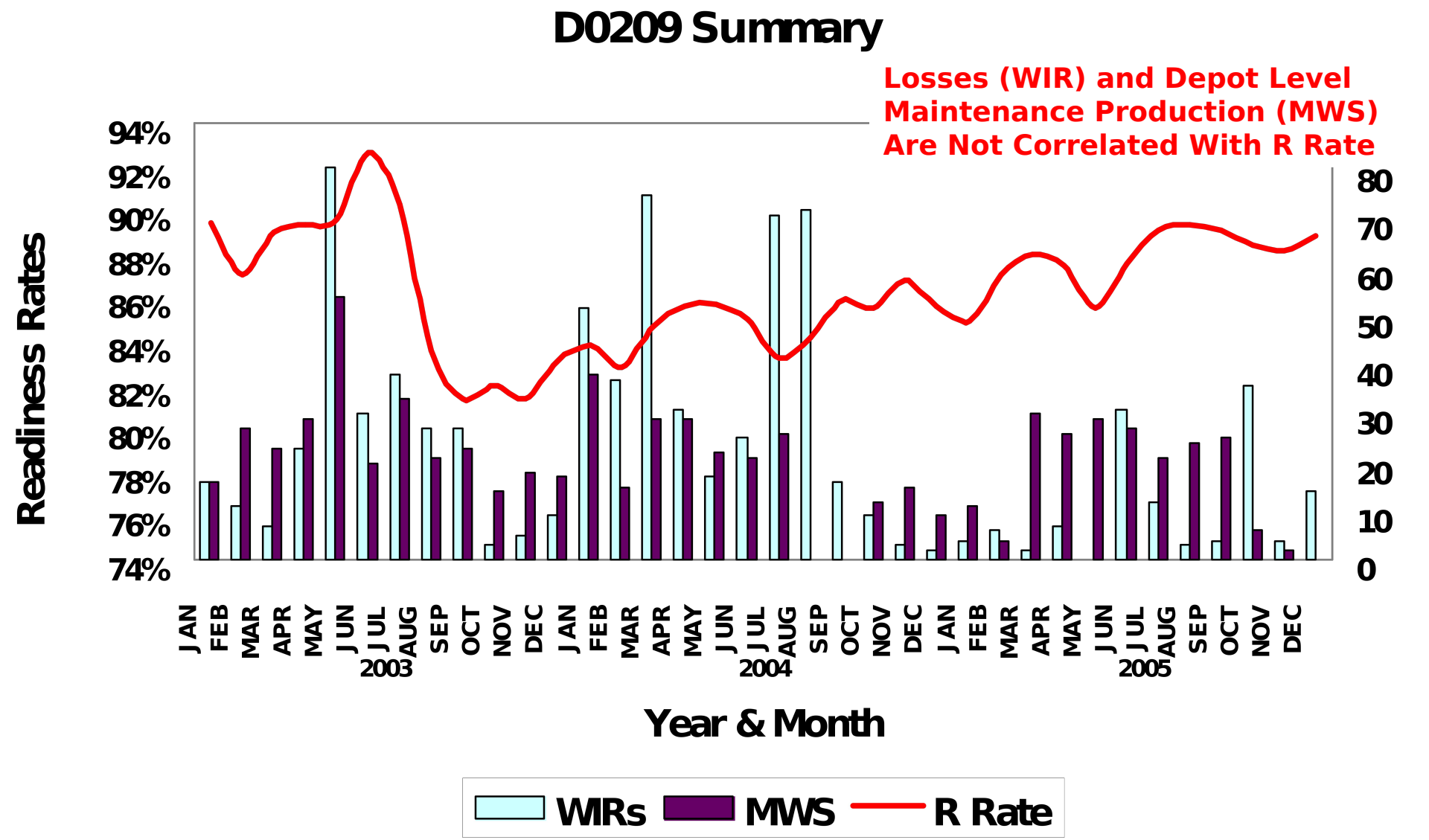


Decreasing Reliability Or Increasing Optempo?

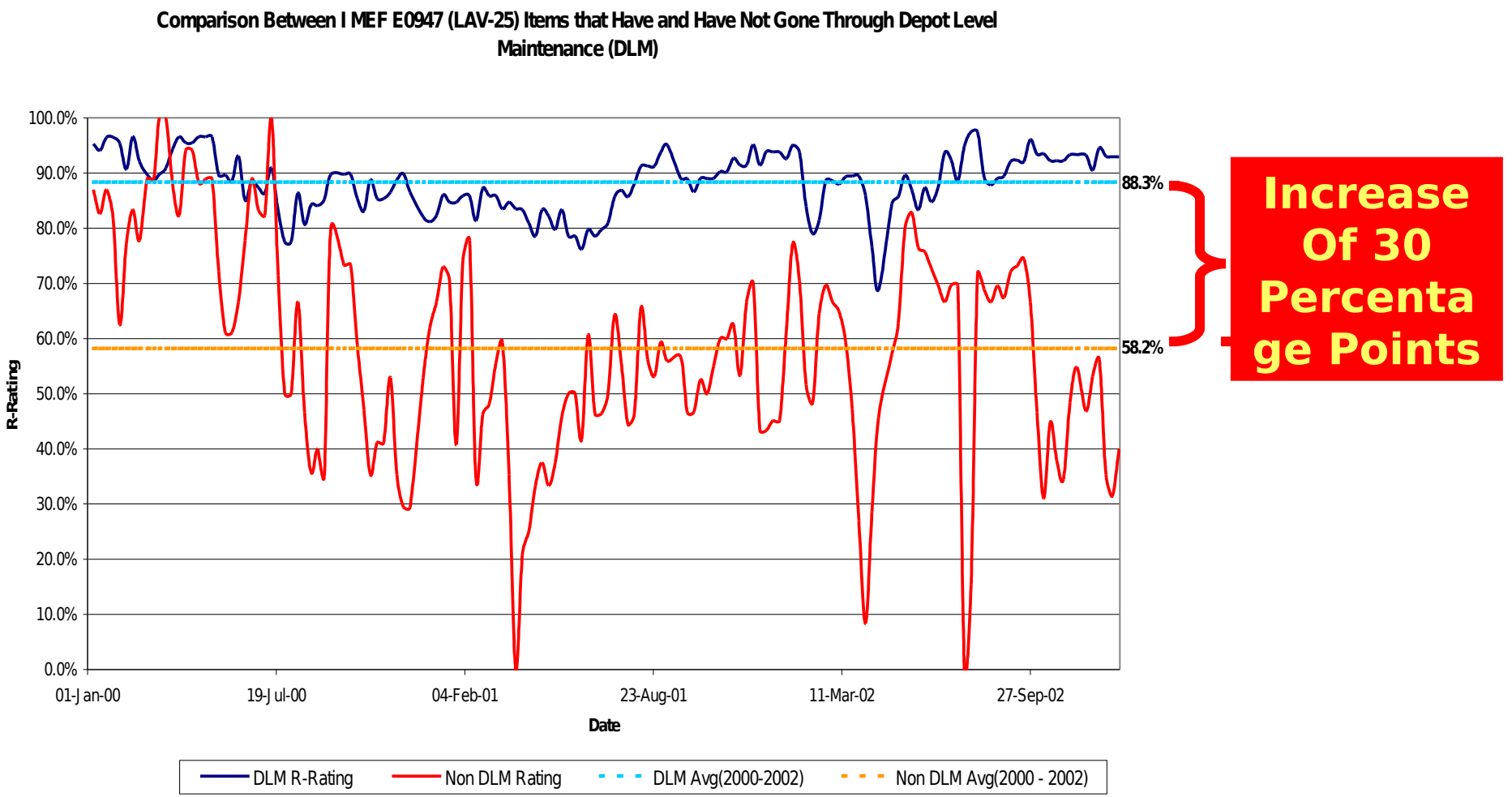
- Data does not currently support standard reliability/MTBF metrics (hours operated, miles drive, rounds fired, etc.)

- However, many historical studies indicate that the Maintenance or “R” readiness rate is highly correlated with reliability
  - Reliability ~ R = (OH – DL) / OH

The Impact Of Losses & DLM on Reliability~ R Readiness Rate

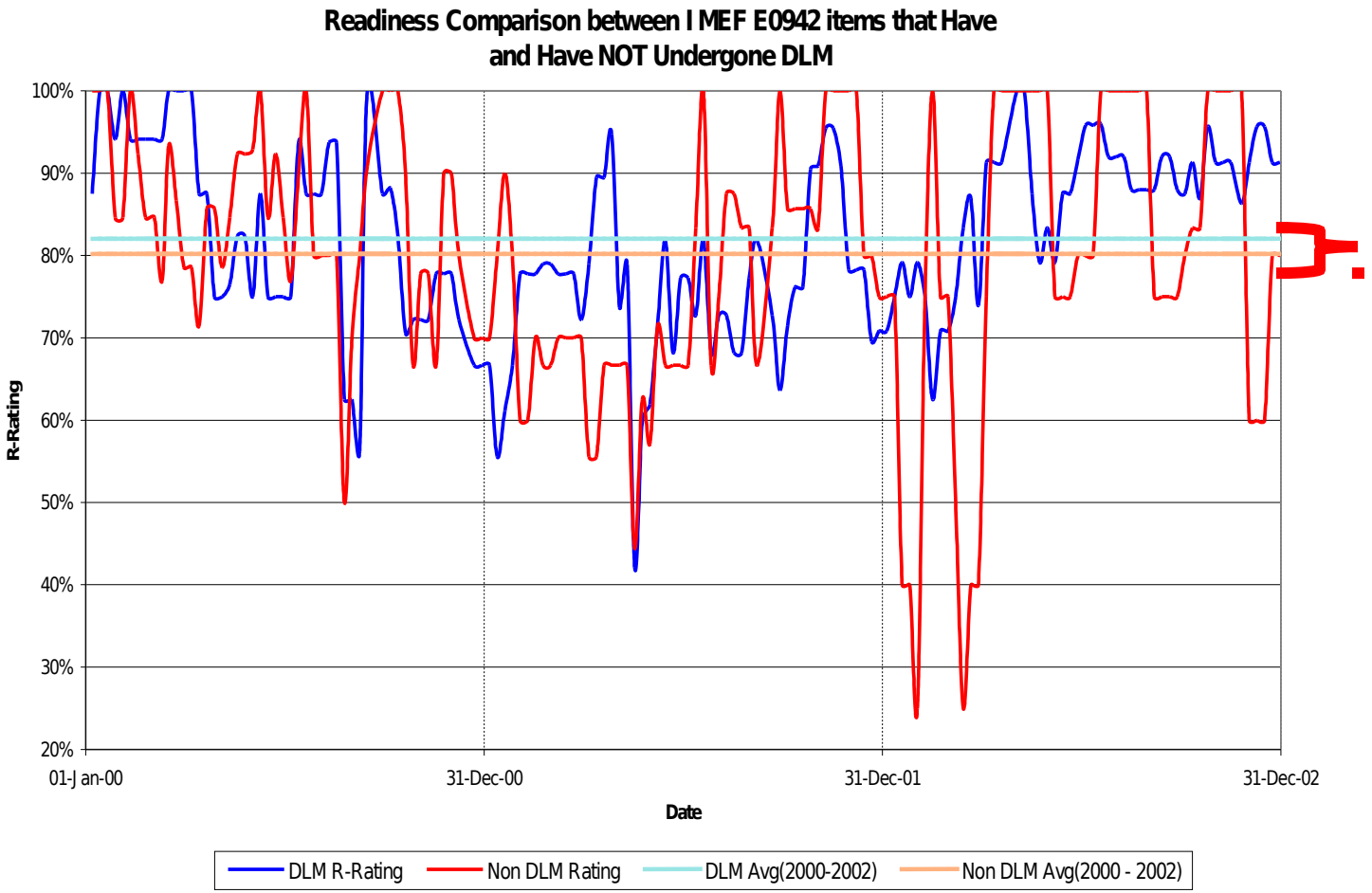


Another Way To Measure Impact of DLM on R Readiness Rate?



I MEF LAV-25 R-Ratings for DLM and Non-

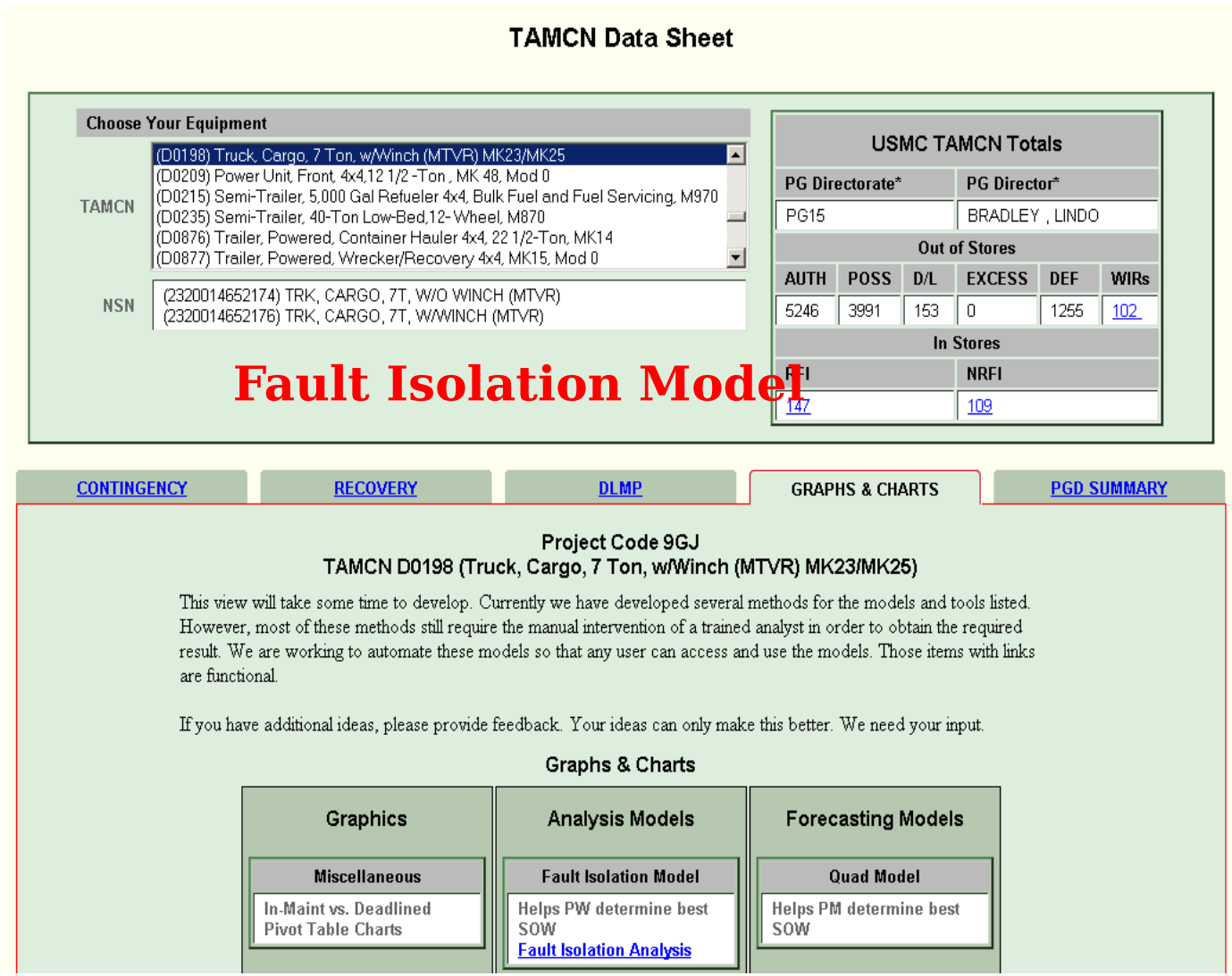
Is Depot Level Maintenance Always Effective?



Increase of only 2 percentage points

I MEF LAV-AT R-Ratings for DLM and Non-DLM

Why Is DLM Not Effective?

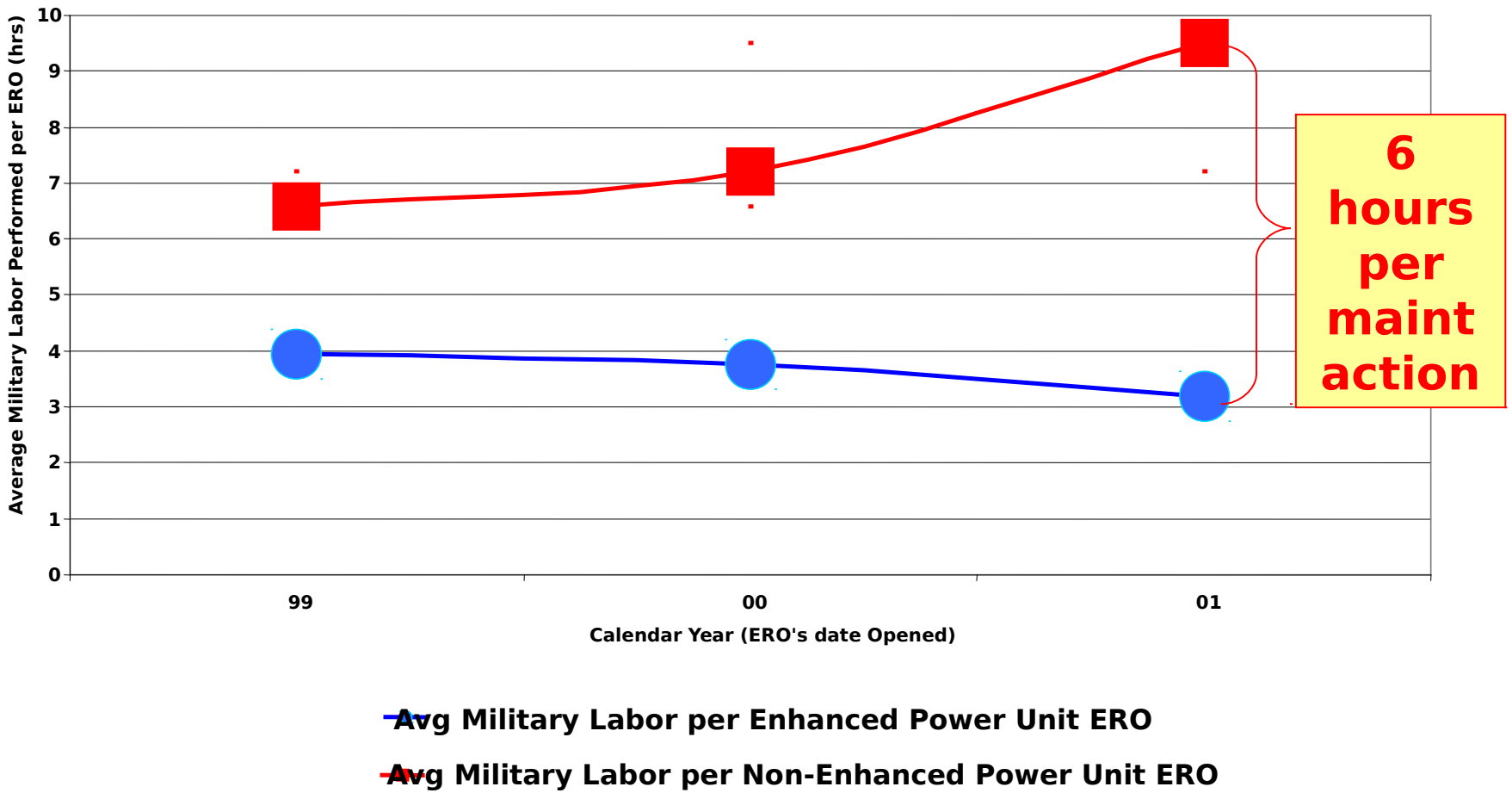

TAMCN Data Sheet
Choose Your Equipment
TAMCN
(D0198) Truck, Cargo, 7 Ton, w/Winch (MTVR) MK23/MK25
(D0209) Power Unit, Front, 4x4,12 1/2 -Ton , MK 48, Mod 0
(D0215) Semi-Trailer, 5,000 Gal Refueler 4x4, Bulk Fuel and Fuel Servicing, M970
(D0235) Semi-Trailer, 40-Ton Low-Bed,12- Wheel, M870
(D0876) Trailer, Powered, Container Hauler 4x4, 22 1/2-Ton, MK14
(D0877) Trailer, Powered, Wrecker/Recovery 4x4, MK15, Mod 0
NSN
(2320014652174) TRK, CARGO, 7T, W/O WINCH (MTVR)
(2320014652176) TRK, CARGO, 7T, W/WINCH (MTVR)
USMC TAMCN Totals
PG Directorate*
PG Director*
PG15
BRADLEY , LINDO
Out of Stores
AUTH
POSS
D/L
EXCESS
DEF
WIRs
5246
3991
153
0
1255
102
In Stores
RFI
NRFI
147
109
Fault Isolation Model
CONTINGENCY
RECOVERY
DLMP
GRAPHS & CHARTS
PGD SUMMARY
Project Code 9GJ
TAMCN D0198 (Truck, Cargo, 7 Ton, w/Winch (MTVR) MK23/MK25)
This view will take some time to develop. Currently we have developed several methods for the models and tools listed. However, most of these methods still require the manual intervention of a trained analyst in order to obtain the required result. We are working to automate these models so that any user can access and use the models. Those items with links are functional.
If you have additional ideas, please provide feedback. Your ideas can only make this better. We need your input.
Graphs & Charts
Graphics
Miscellaneous
In-Maint vs. Deadlined Pivot Table Charts
Analysis Models
Fault Isolation Model
Helps PW determine best SOW
Fault Isolation Analysis
Forecasting Models
Quad Model
Helps PM determine best SOW

Is The DLM SOW Adequate?
Fault Isolation Model

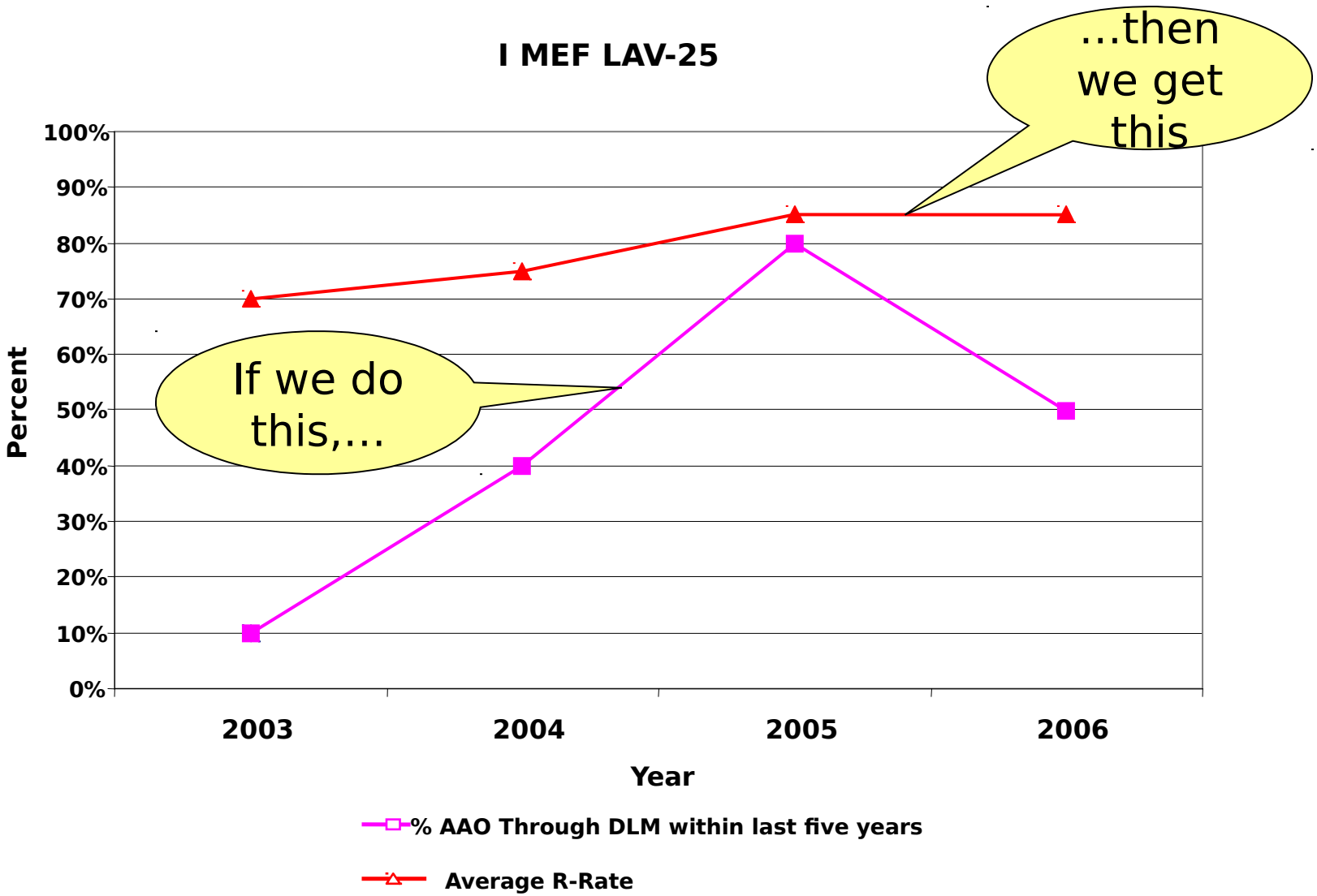
Fault Isolation Analysis Results for
TAMCN Radio Set, MRC-138B(V) (A1935)

PRI	NIIN	NOMENCLATURE	UNIT PRICE	NUM ROs	AVG CWT (Days)	CWT N/As	PQDRs	CAT Ms	COMPOSITE SCORE
1	000433463	HANDSET	$37.15	169	263.80	11	1	72	11.216
2	002202691	CABLE,SPEC	$0.76	67	1154.85	2	0	43	6.198
3	007809126	CONNECTOR,	$48.18	76	537.04	2	0	41	5.728
4	005181793	FUSE,CARTR	$0.23	95	415.41	3	0	28	3.870
5	003069520	INSULATION	$20.98	31	1273.10	1	0	12	2.625
6	007336042	ANTENNA EL	$45.64	47	24.85	5	0	16	2.136
7	007336047	PLATE,ANTE	$126.66	32	18.72	0	0	15	2.088
8	007336048	CASE,ANTEN	$53.37	112	23.32	4	0	14	2.082
9	001863912	CLAMP,ELEC	$1.06	118	38.45	1	0	14	1.916
10	003958799	WIRE,ELECT	$0.18	107	33.58	1	0	15	1.836
11	007336043	ANTENNA EL	$53.44	32	24.44	2	0	13	1.800
12	002719504	TERMINAL,L	$4.73	83	492.95	1	0	11	1.789
13	005426092	CABLE,RADI	$0.13	22	43.45	0	0	15	1.731
14	007336046	ANTENNA EL	$51.41	68	28.72	2	0	13	1.585
15	007336045	ANTENNA EL	$49.40	31	26.87	2	0	11	1.525
16	007250969	RING,RETAINING	$0.07	7	29.14	0	0	7	1.260
17	007336044	ANTENNA EL	$53.95	29	32.48	2	0	8	1.111
18	001141300	TERMINAL,L	$4.11	6	3.17	0	0	5	0.997
19	006521784	WIRE,ELECT	$0.01	23	69.74	0	0	10	0.958
20	004512924	THUMBSCREW	$5.10	30	37.47	0	0	9	0.935
21	006143506	WASHER,FLAT	$0.12	7	74.14	0	0	7	0.907
22	006821427	BUSHING,NONMETALLIC	$0.31	14	116.64	0	0	5	0.752

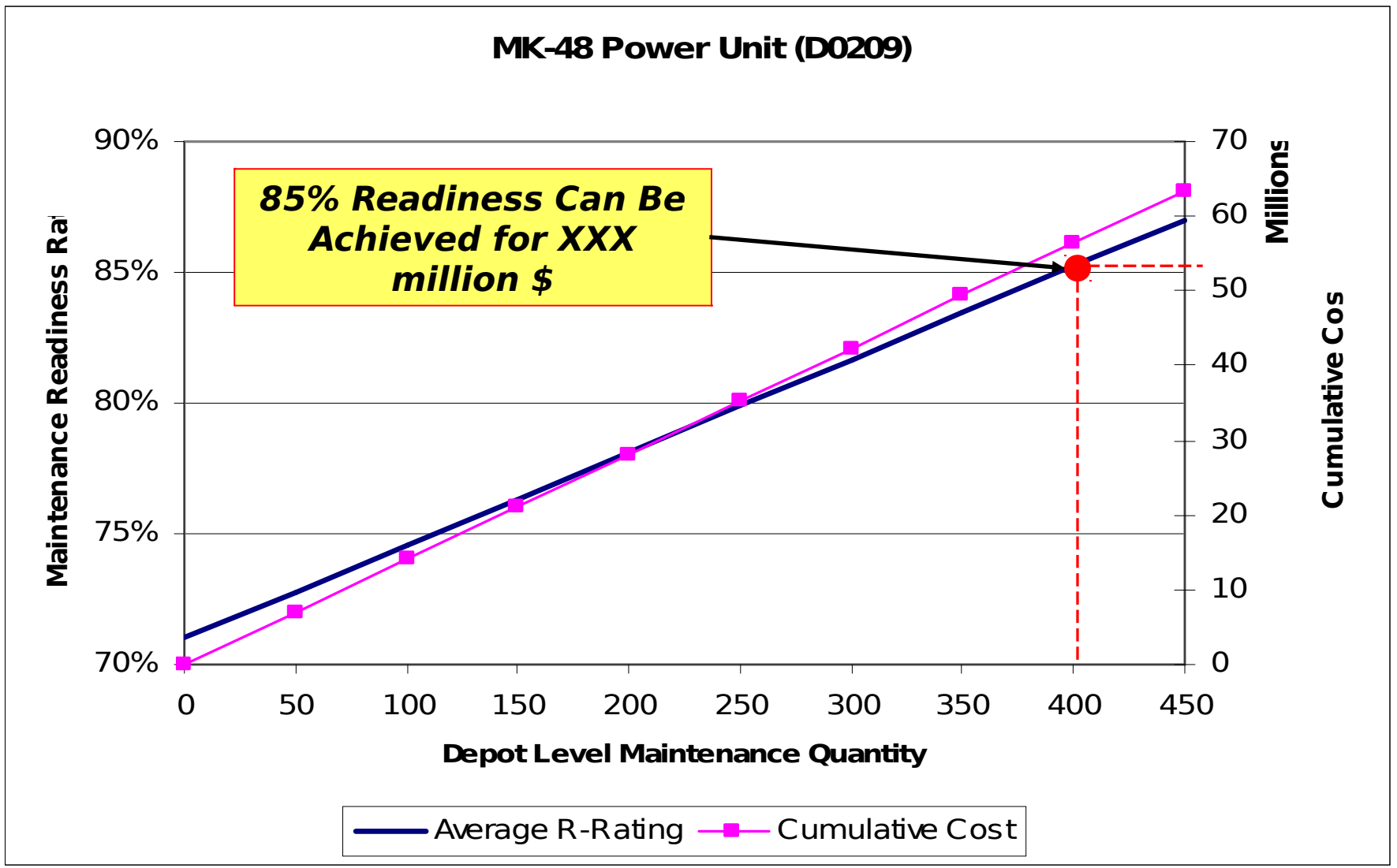
DLM Impact Is Measurable Reduces Level Of Effort in the Fleet

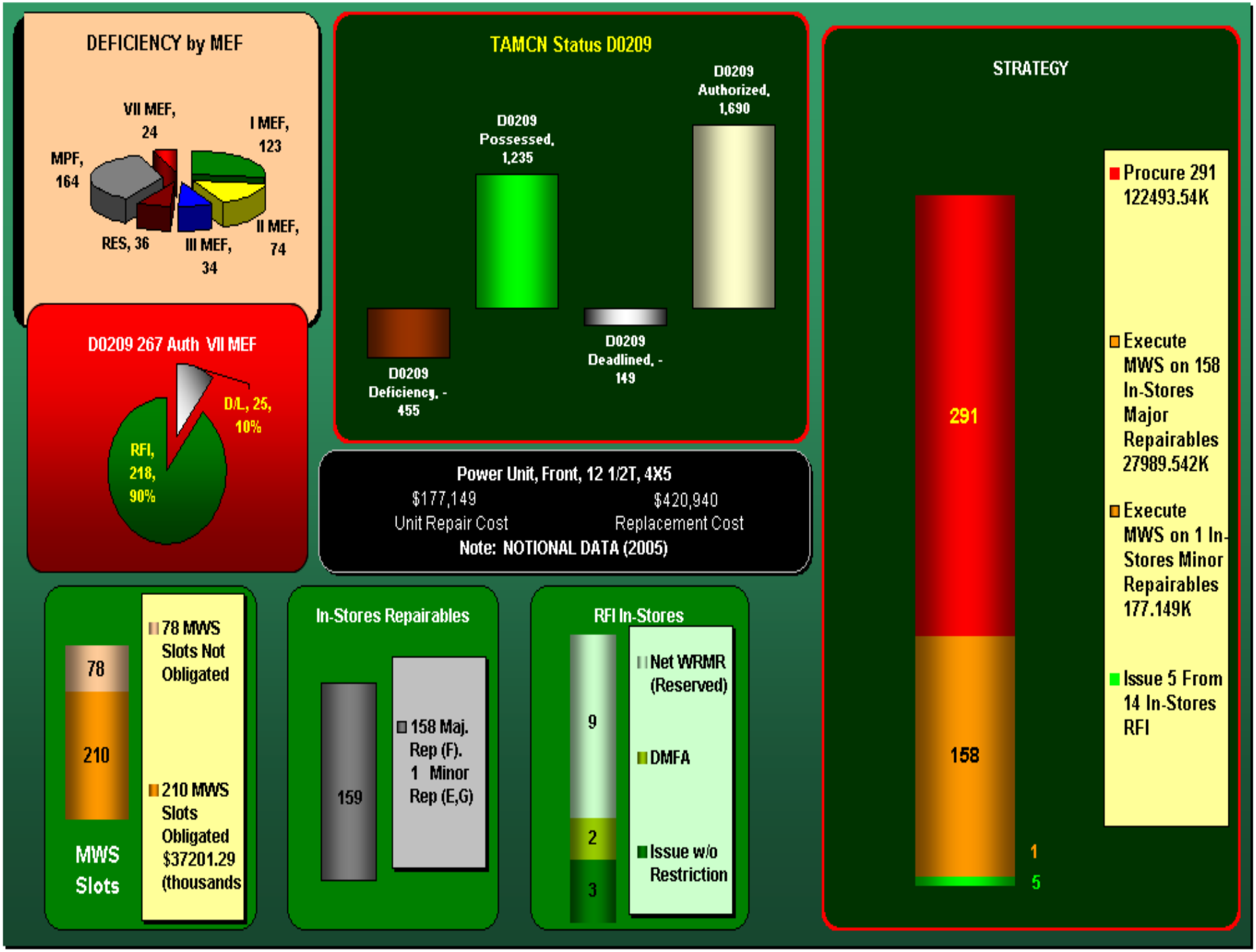


Readiness Return On DLM Is Predictable



Basing Decisions On Predictable Outcomes




DEFICIENCY by MEF
VII MEF, 24
I MEF, 123
MPF, 164
II MEF, 74
RES, 36
III MEF, 34
TAMCN Status D0209
D0209 Authorized, 1,690
D0209 Possessed, 1,235
D0209 Deficiency, -455
D0209 Deadlined, -149
STRATEGY
Procure 291 122493.54K
Execute MWS on 158 In-Stores Major Repairables 27989.542K
Execute MWS on 1 In-Stores Minor Repairables 177.149K
Issue 5 From 14 In-Stores RFI
291
158
1
5
D0209 267 Auth VII MEF
D/L, 25, 10%
RFI, 218, 90%
Power Unit, Front, 12 1/2T, 4X5
$177,149
Unit Repair Cost
$420,940
Replacement Cost
Note: NOTIONAL DATA (2005)
78
210
MWS Slots
78 MWS Slots Not Obligated
210 MWS Slots Obligated $37201.29 (thousands
In-Stores Repairables
159
158 Maj. Rep (F). 1 Minor Rep (E,G)
RFI In-Stores
9
2
3
Net WRMR (Reserved)
DMFA
Issue w/o Restriction

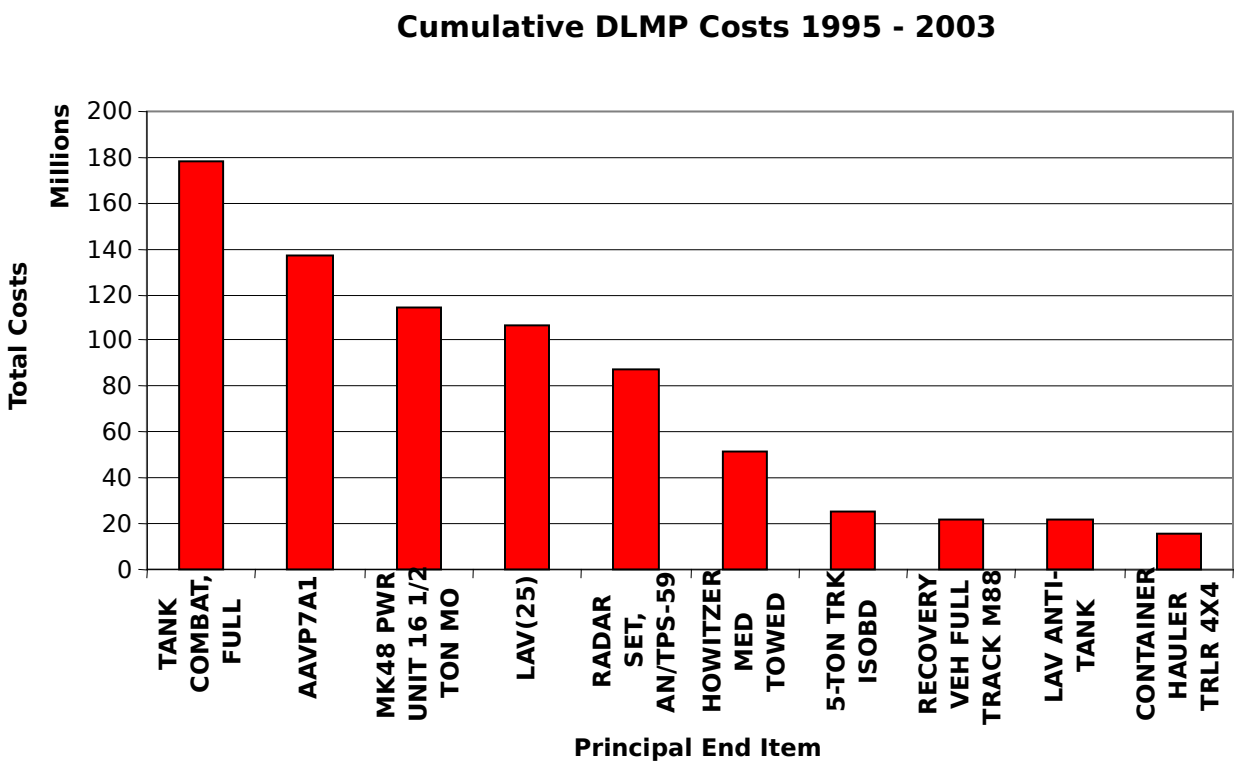
Critical Systems

- Large Number of Systems
  - Not all are equally important
  - Criticality is situation dependent
    - E.g., Heavy Armor Combat vs. NEO
- How Can We Identify The Most Critical Systems?

How Do You Define Critical?

- Most Expensive to Repair?
- Greatest Replacement Cost
- Least Reliable?
- Hardest to Maintain?
- Greatest Attrition Rate?
- Oldest?
- Greatest Increase in Maintenance Effort?
- Greatest Increase in Sustainment Costs?
- Mission Essential?
- MEF OPLAN Requirements?
- MPF Prepositioning Requirement?

Top Ten Most Expensive PEIs



y surprises here?...Nope, Tanks are expensive...so wha

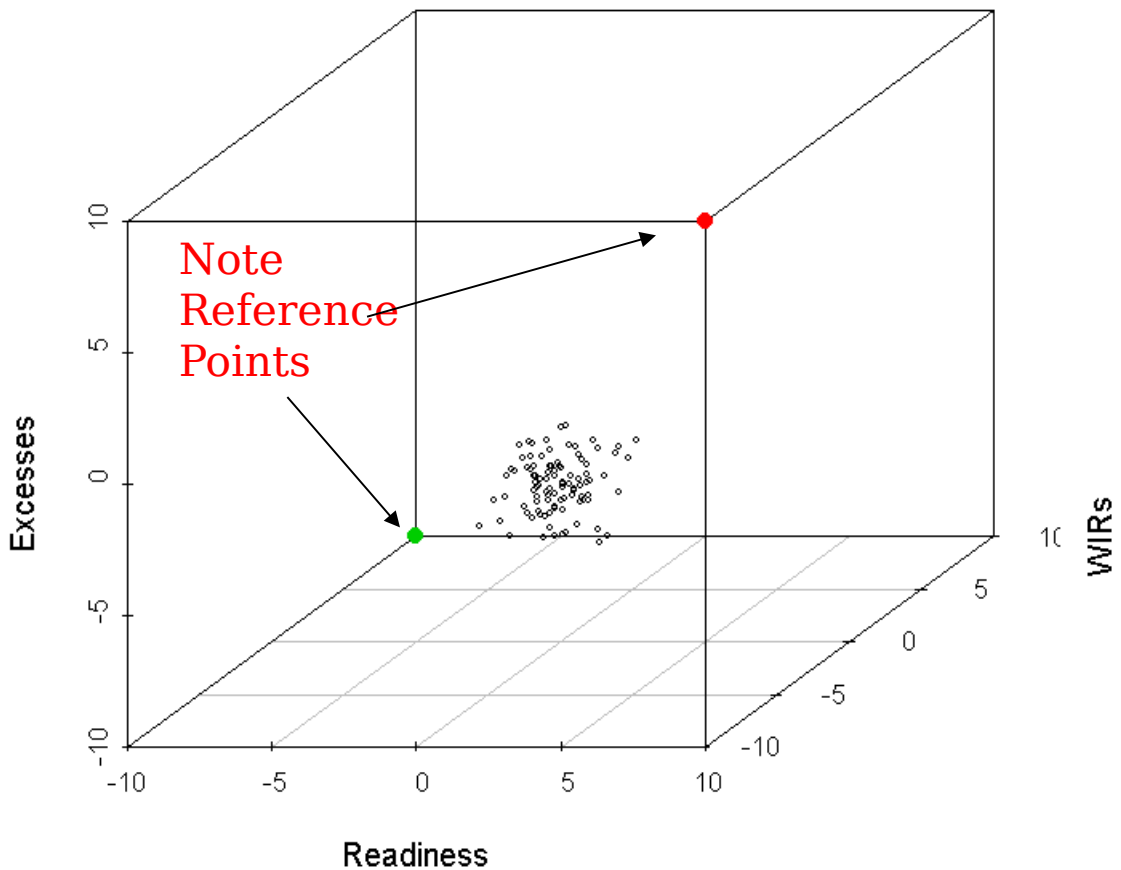
A Better Way

(Put the Data to Work)

- Identify Essential Characteristics
- Multi-Dimensional vs. One-Dimensional
- Use Principal Component Analysis
  - Retains “Information” Reduces “Dimension”
  - Spectral Decomposition of Correlation Matrix
  - Algorithm Determines Coordinate System Showing Optimal Perspective
- Finally, Clustering Algorithm (KMeans) Defines Thresholds between Most Critical and Less Critical Systems

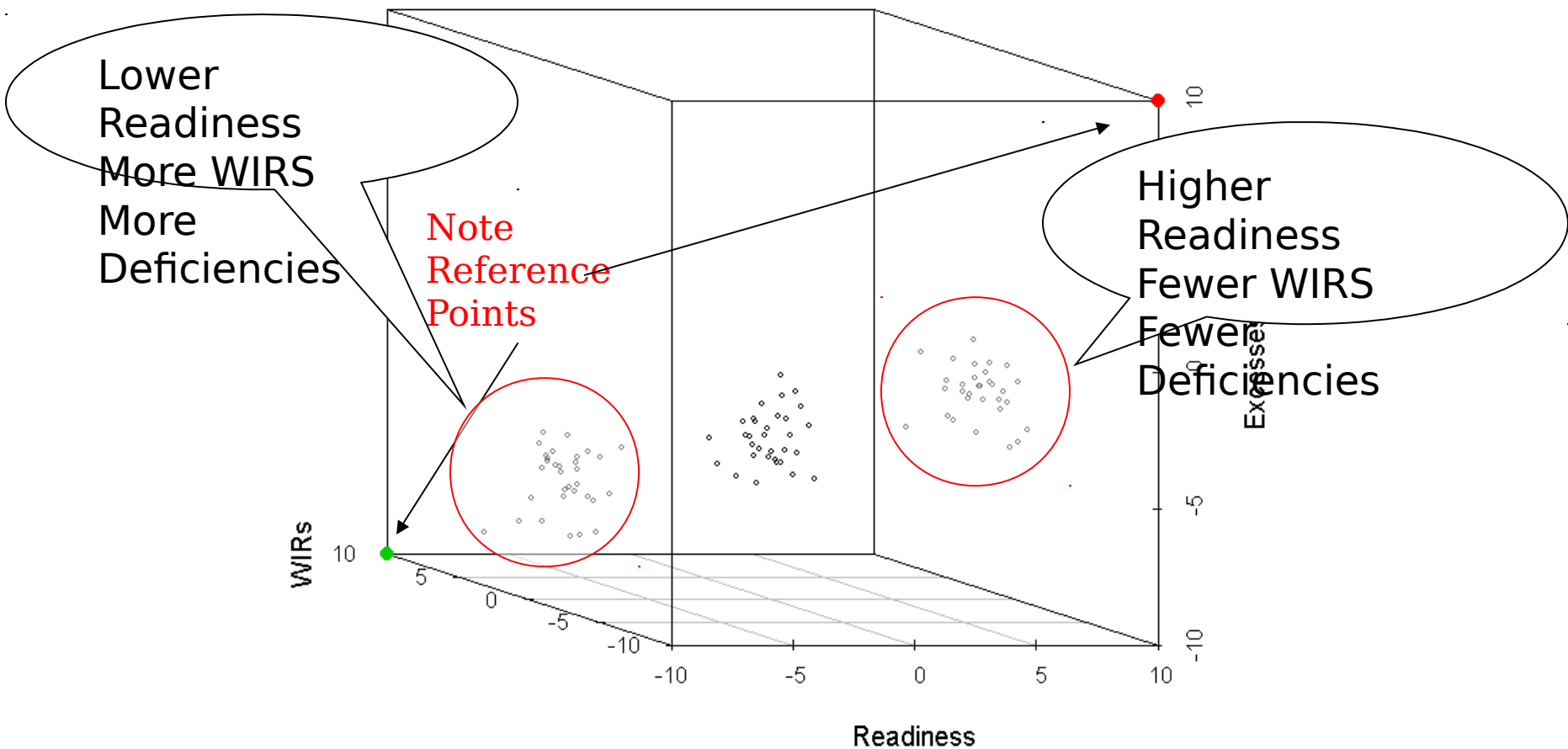
Three Dimensional Data

(Difficult To Distinguish Between The Points)

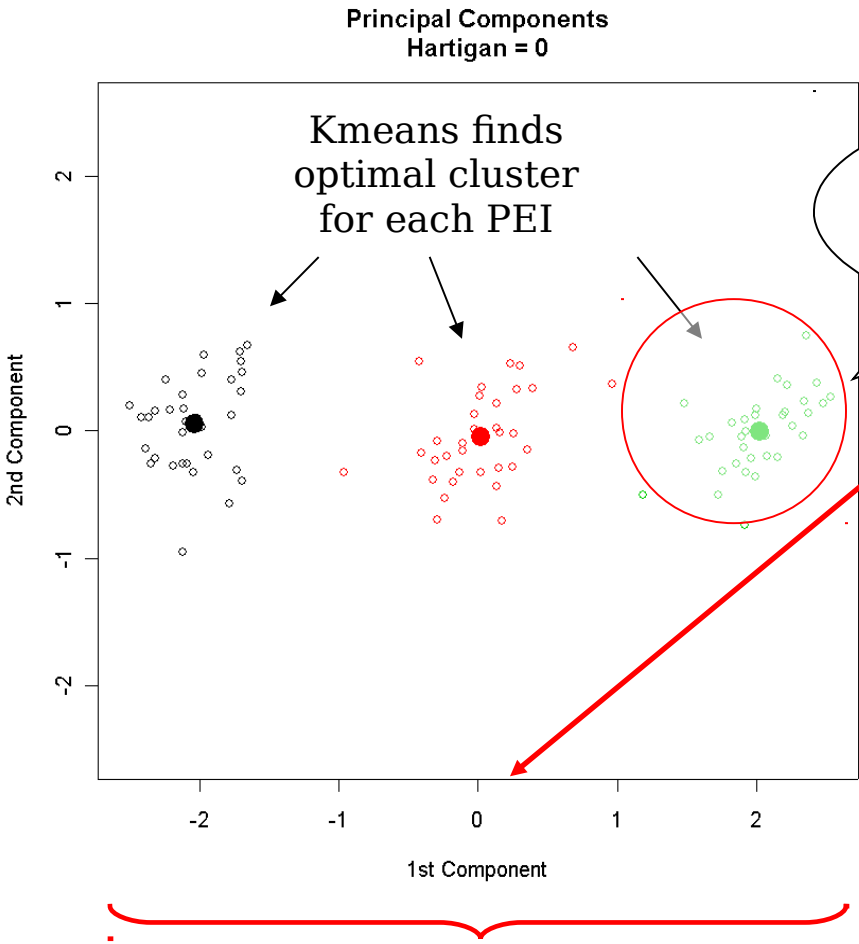


Same Data... Different Perspective

(Clearly Distinguishable Clusters of PEIs)



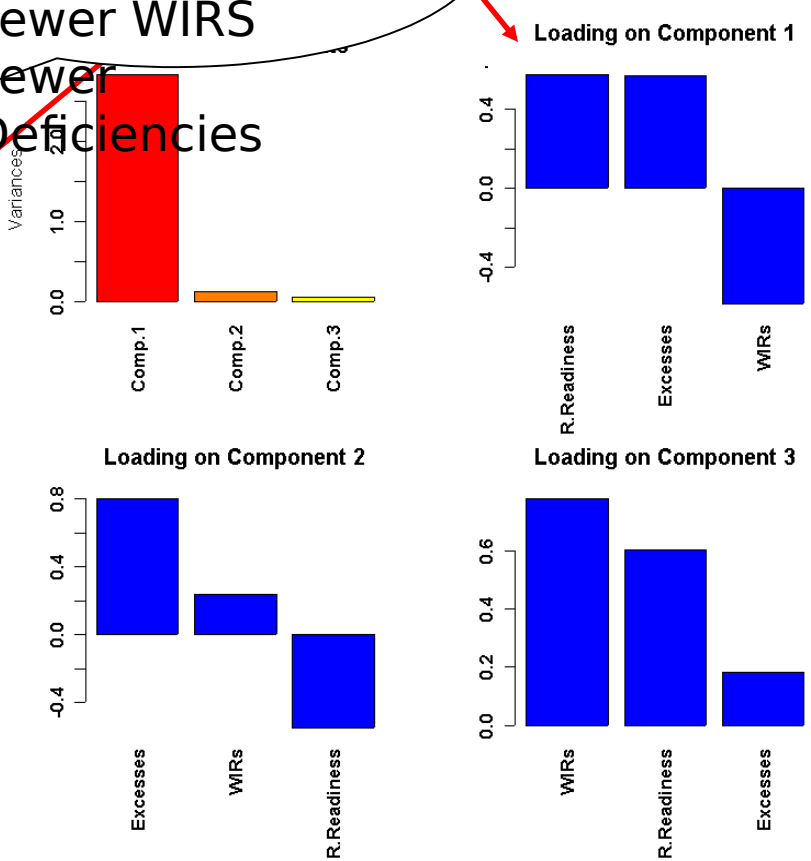
The Best Perspective



PCA rotates coordinate system to show greatest spread between PEIs

Use Barcharts To

Higher Readiness
Fewer WIRS
Fewer Deficiencies



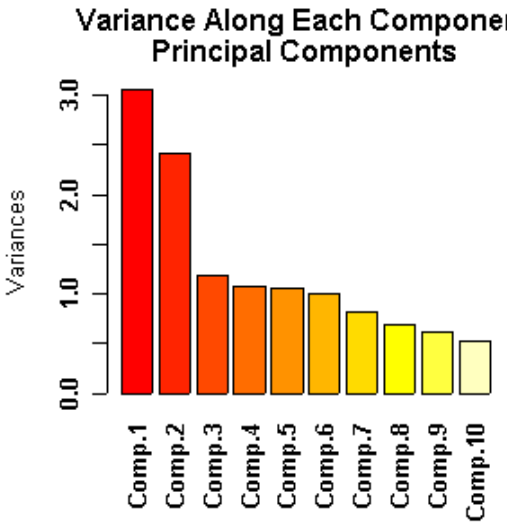
An Example

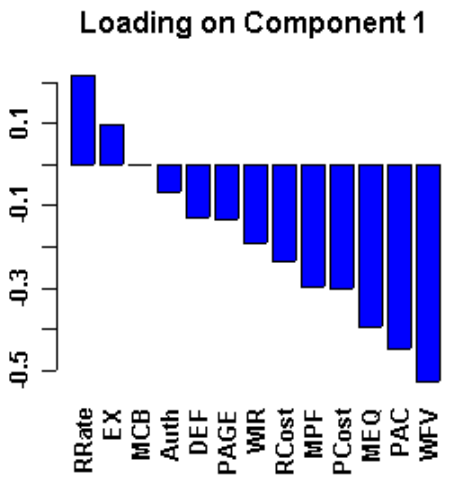
Principal Component Analysis

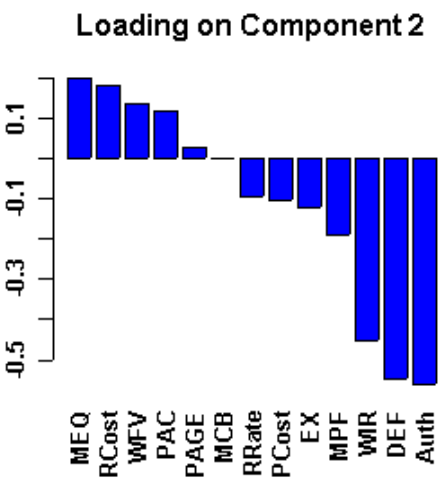
- Identify Essential Characteristics
  - 12 Month Average:
    - Allowance
    - Possessed
    - Excess
    - Deficiency
    - Deadlined
    - CAT M Echelon 2
    - CAT M Echelon 3
    - CAT M Echelon 4
  - Age this year
  - Life Expectancy
  - Damaged Repairable
  - Damaged Not Repairable
  - On "Mission Essential" List
  - Affordability Index (Support Costs) / [(Replacement Cost)*(MR Rate)]
  - Average Equipment Density Requirement Next 36 Months
- Reduce 15 Dimensions to one

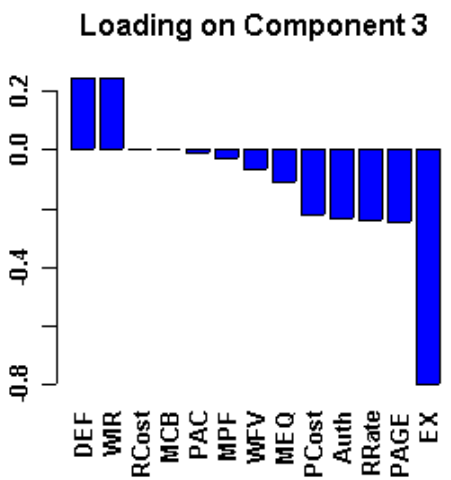
Graphically

- Data on the 15 equipment characteristics (from previous slide) collected on all MCBul 3000 TAMCNS
- Data normalized
- PCA algorithm
- First two dimensions are orthogonal and explain the majority of the data's variance.

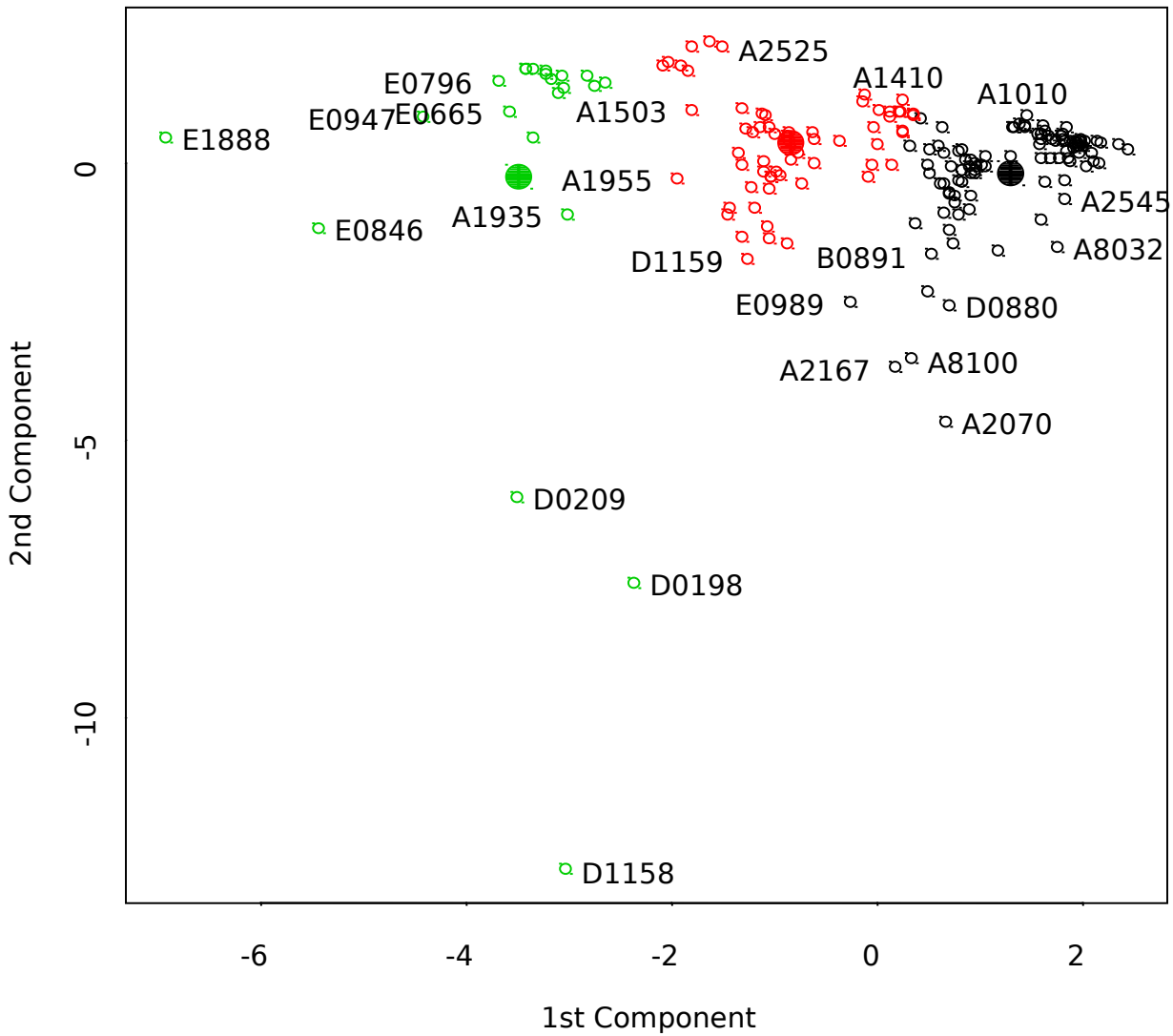








A Graphical Representation



Bottom & Top Ten

Rank	TAMCN	Name
-6.93	E1888	M1A1
-5.42	E0846	AAVP7A1 RAM/RS
-4.41	E0947	LAV-25
-3.69	E0796	AAVC7A1 RAM/RS
-3.58	E0665	M198
-3.50	D0209	MK48A1 MOD0
-3.42	E0856	AAVR7A1 RAM/RS
-3.42	E0942	LAV-ATA1
-3.35	E0949	LAV-M
-3.34	E0935	M220A3
1.99	A1520	AN/TSQ179(V)2
2.00	A8038	TSEC/KG40A-P
2.02	A3235	AN/TSQ190(V)2
2.03	E0727	AN/PPX3B
2.09	A1530	AN/PPN19(V)2
2.11	E1837	AN/PAS18
2.14	A2629	AN/MYQ8A
2.16	E1475	M82A3
2.18	A2634	AN/UYQ83
2.35	A1219	SS2
2.45	A0873	AN/UYQ91(V)2

10 Most Critical Systems (DLMP Candidates? Mission Essential List?)

10 Least Critical Systems (Not DLMP Candidates? Not Mission Essential List?)

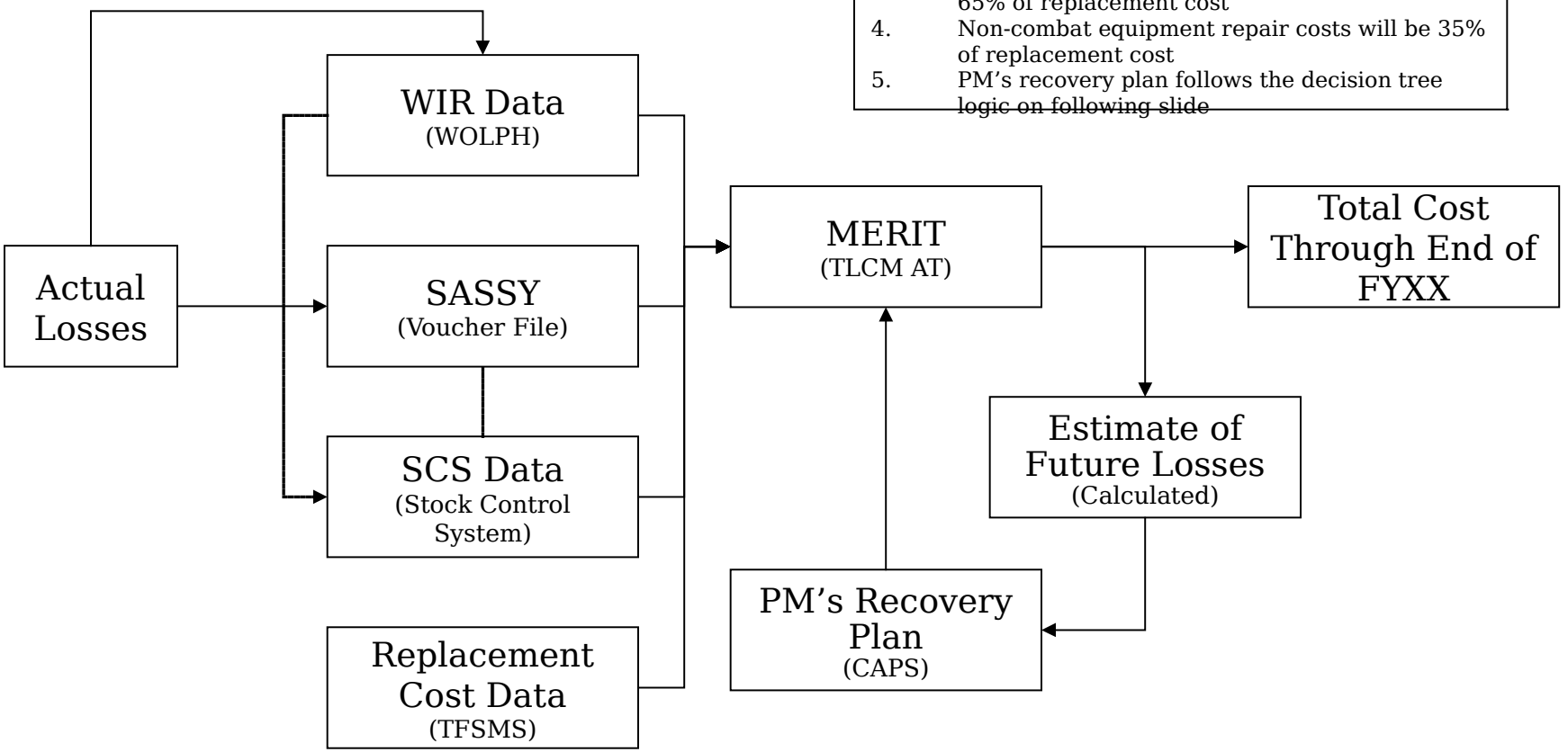
Forecasting DLM Requirement

Equipment Attrition

How does MCDSS do it?

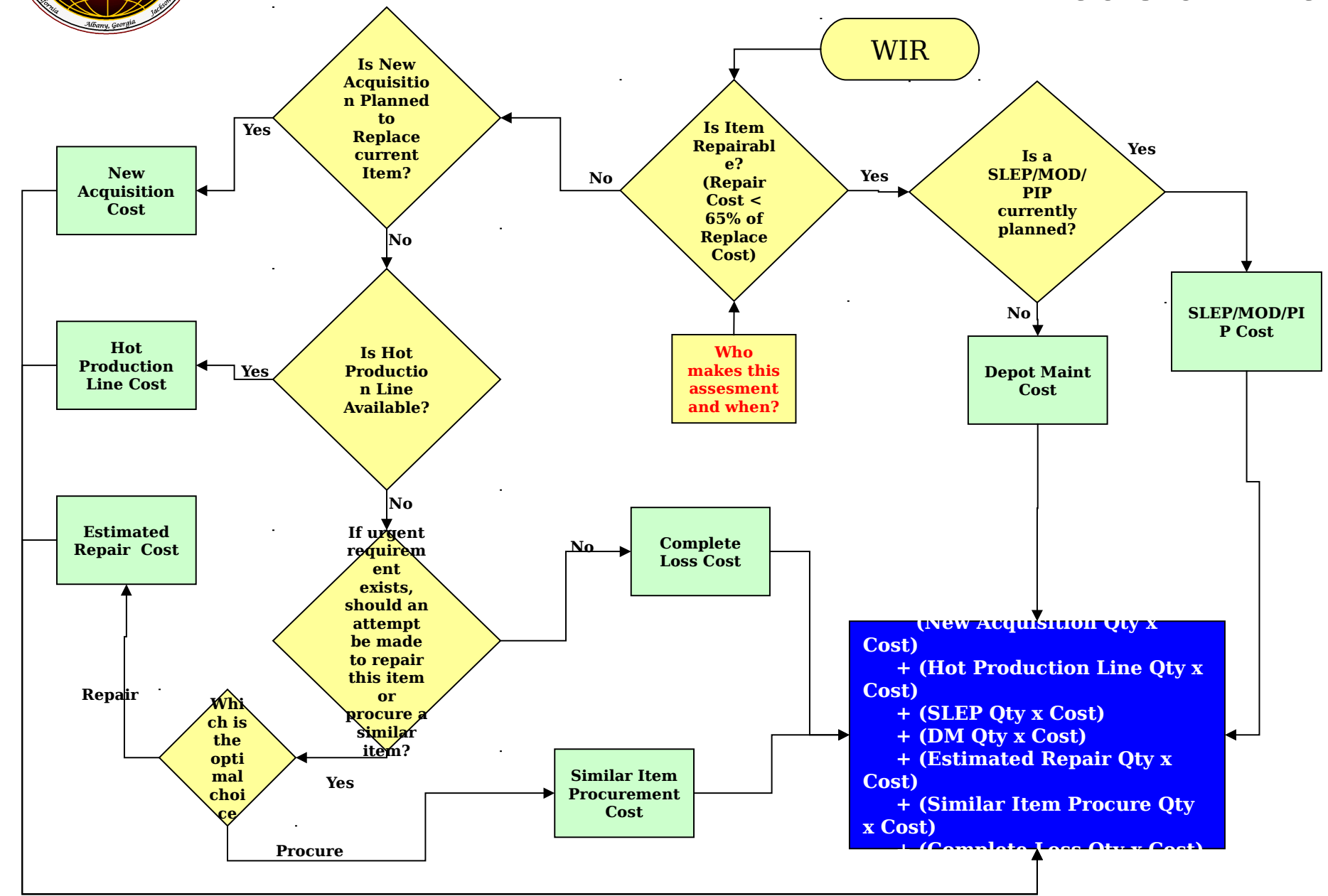
Assumptions:

1. TFSMS contains accurate replacement costs
2. WIR from WOLPH contains accurate NSN and quantity data
3. Combat damaged equipment repair costs will be 65% of replacement cost
4. Non-combat equipment repair costs will be 35% of replacement cost
5. PM's recovery plan follows the decision tree logic on following slide



Repair/Replace

Decision Tree



Collaboration

Shared Data Environment

Life Cycle LCMI Modeling Integrator

GCSS-MC

LCMI

MCSC AC PROD
WSTIAC
SOE (RAM)

PM FSS
HIT/EWRB

Supply & Maint Data

Electronic Gunbook Data

Failure Rates

MIMMS & ATLAS Data

SDE
MDR
Failure Rates

MDR

Legacy Transactional Systems

Day / Time	10:00	10:30	11:00	11:30	12:00	12:30	13:00
Thur	MSST		Fault Isolation			DLMP	
Fri	Total Life Cycle Management AT					Battle Space Command Supply Support System	
Sat	DERO	TAMCN Report			SCOPE		50/50 Report
Sun	Total Support Cost				MERIT		
Mon	Howitzer Information Tool		Attrition Report		Redistribution Model		

MERIT

10

PM LAV Future
NCMS Oracle Web
Application

Migrate

PM LAV Current
NCMS Access dB
Application

Necessary Data Feeds

Readiness Predictions

Readiness Predictions

Necessary Data Feeds

HQMC LPC-2
Clockworks Solutions
ATLAST
Predictive Modeling

Courses Of Action

- Current State
  - Several systems,
  - Developed independently,
  - Incomplete
- Two Possibilities
  - Continue independently
  - Collaborate
- End State
  - Continue Independently:
    - Three nearly identical systems with separate databases, web-based application interfaces at, potentially, three times the cost, takes longer
  - Collaborate:
    - One integrated system with a shared data environment, reduced cost, more efficient, objective achieved sooner

Benefits Of Collaboration

- Reduces Costs
- Obtains Capability Faster
- Leverages Best Of Breed
- Helps Pave The Way For GCSS-MC Implementation
  - Bridges The Gap Between Old & New
  - Identifies & Documents Requirements
- Improves Support To MARFORs

"That's all Folks!"
Cartoon Songs From
MERRIE MELODIES & LOONEY TUNES

Questions?